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THE

PRINCIPLES OF MEDICINE,

FOUNDED ON THE

STRUCTURE AND FUNCTIONS

OF THE

ANIMAL ORGANISM.

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Cum nil sine ordine et lege fiat, ita vitæ nostræ integritas naturali lege constat.—*Hoffman*.

PHILADELPHIA:
CAREY & LEA.

1832.

SKERRETT—NINTH STREET,
PHILADELPHIA.

TO

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THIS WORK IS INSCRIBED,

AS A TESTIMONY

OF RESPECT,

FOR THE TALENTS WHICH HAVE ELEVATED HIM TO THE HIGHEST HONOURS OF HIS PROFESSION:

OF ESTEEM,

FOR THE SOCIAL VIRTUES WHICH MAKE HIM ONE OF THE BRIGHTEST ORNAMENTS OF SOCIETY:

AND

OF GRATEFUL SENTIMENTS,

FOR REPEATED INSTANCES OF DISINTERESTED FRIENDSHIP AND OF UNSOLICITED FAVOURS,

BY THE AUTHOR.

CONTENTS.

PREFACE.

In every progressive science periods arrive when a new impulse is imparted to its cultivation, and a new direction is impressed upon its course. These epochs proceed from the discovery of new facts, shedding a light which changes the whole aspect of the science, the greater precision and accuracy given to the facts before known by more careful and cultivated observation and rational experience, and the consequent establishment of principles of more extended application. At such periods the works which have served as guides are impaired in importance and value, lead astray from the direction in which the science progresses, and new ones are demanded to supply the position in which they become faulty. The present is an epoch of this kind, and the work now presented to the public has no higher pretensions, than to serve to the *student* as an indicator to the line of march now taken up by the science of medicine.

The want of a treatise on the practice of medicine in the room of those usually placed in the hands of students and young practitioners had been long felt. It was proposed to me to undertake the work, and immediately on assenting to the proposition, without my knowledge, it was announced to the public. I thus found myself committed to the task before I had sufficiently reflected on its nature, the plan to be adopted, or the system best calculated to fulfil the object desired. At first I merely contemplated a practical book, compiled in the usual manner, founded on the experience of preceding writers, compared with, corrected and extended by my own. I had made a considerable progress in this method, when I was arrested by the conviction that it was essentially defective, that it did not meet the spirit of the age, that it did not answer the purposes of a rational instruction, that it did not supply the deficiency I had felt to exist in the commencement of my profession, that it had been followed in a servile spirit from the remotest eras of the science, and is most probably the cause, that

after so long a period of cultivation, its practice still continues of uncertain and doubtful application.

What is called experience in medicine, daily observation and reflection confirms me in the conviction, is a fallacious guide, not more entitled to the implicit confidence claimed for it than when it was thus characterized by the great father of the science—*fallax experientia.* In fact, experience cannot exist in medicine, such as it is in those arts in which experiments can be made under circumstances invariably the same, and attended consequently with invariable results. It is quite otherwise in medicine. Individuals differ from each other in so many particulars; they vary in constitution, in temperament, in the development and power of their organs, in the forces of life and energy of their functions, to such an extent; the human mechanism is of a structure so complicated, the elements of its constitution present so many and diversified combinations, it must always be the merest casualty, that two beings, even in health, much less in disease, should be found in circumstances precisely similar. No one, therefore, though endowed with the greatest sagacity, resting solely on experience, can pretend to more than probabilities in determining the results in one case from results in another.

In medicine, the *evidence* of practice is incessantly confounded with and mistaken for experience; but the practitioner who only possesses this evidence, can do no more than testify to apparent, not absolute conditions, and consequently is liable to frequent deception. This distinction is drawn by Dugald Stewart in his Philosophy of the Human Mind, who, speaking on this subject, correctly observes, that "in every instance, without exception, so immense is the distance between them, as to render the meaning of the word experience, when applied to medicine, essentially different from its import in those sciences, where it is possible for us, in all cases, by due attention to the circumstances of an experiment, to predict its result with an almost infallible certainty." This was the view taken of medicine by the celebrated La Place, when he proposed that the practice of medicine, as drawn from experience so called, should be submitted to the mathematical doctrine of chances.

But medicine is not a preceptive art to be acquired simply by

committing rules and specified formula to memory, subsequently to be applied in practice under the direction of the senses. It is a demonstrative science, and all its processes should proceed from established principles, and be based on positive inductions. That the proceedings of medicine are not of this character, is to be attributed to the manner of its cultivation, and not to the nature of the science itself. The phenomena of the human organism, structural and functional, physiological and pathological, those that are the effects of remedial agents, of food, and whatever is capable of influencing the economy, are the subjects of observation, can be reduced to experiment, and are cognizable by the senses. They occur after certain modes, they are subjects of causality, they take place in a fixed order of occurrence, and are, consequently, capable of arrangement in the order or series of their occurrence. When these are established, or formulæ of the phenomena of the elemental principles of the animal structure, of the tissues, of the organs and functions in their varied conditions under the influence of normal and abnormal agencies, are constructed, medicine will then possess positive principles of extended application, and will offer the materials for reflection, combination, reasoning, and induction, in every case presented to observation. But this has not been the course pursued in medical science, or the spirit of its practical works. A late judicious writer remarks, that "medicine never continued long an art of unbiassed observation, and has never yet known the fertilizing influence of the inductive logic."*

The uncertainty that attends on medicine, and with which it is so frequently reproached, prevailed in every department of science before the introduction of positive philosophy, and still continues in those in which it has not yet been admitted. Let it be allied to medicine, let medical science be prosecuted in the spirit, and its investigations be conducted under the precepts of a positive philosophy, and there can be no hesitation in believing that a degree of certainty will attach to the calculations, and attend the practice of the science, of which at present it is difficult to form a comprehension.

* The Book of Analysis. By Tweedy John Todd, M. D.

From this train of reflexions the plan originally adopted was abandoned, and it was thought a more lasting and useful performance would arise by attempting, though the execution of the work must of necessity prove defective, the establishment of principles of general application, derived from an analysis of the phenomena manifested in the structure and functions of the animal organism.

A work of this kind, it is by no means improbable, may not prove popular. Students and practitioners too frequently expect practical works, so constructed as to save them the labour of thought. They look for arrangements and categories of symptoms, which shall embrace every variety of disease, and meet the exigencies and even varying circumstances of particular cases. They require didactic rules, positive instructions, formulæ and prescriptions of approved efficacy and certain operation, applicable on clear indications to the diversified and mutable incidents of the pathological condition. These expectations are chimerical. The human organism is not a mechanism of uniform structure and arrangement, acting in one uniform mode in every individual: nor can a physician be reduced to the capacity of a mere engineer, passively superintending the movements of a mechanical machine. Subject to endless variety in the combinations of its remote and its proximate organic elements, in the energy of its forces, the manifestation of its phenomena, and modes of existence, the animal economy requires, in order to its perfect comprehension, the most profound investigation, combined with deep and careful reflexion. Every case presents itself as a distinct problem, is to be studied separately, and its specific nature and relations are to be deduced and solved by the application of fixed principles on the rules of philosophic calculation. The elements of this calculation, the principles that form its radix, are the propositions evolved from the analysis of the phenomena of the organism, a full and comprehensive knowledge of its structure, forces, and functions, in their physiological and pathological modes of being, thoroughly investigated and clearly established by clinical and autopsical observation, and minute anatomical research. This system can alone confer on the proceedings of the practitioner the attribute of a rational method—without which, in the lan-

guage of Dugald Stewart, "his practice cannot with propriety be said to be guided by any one rational principle of decision, but only by blind and random conjecture."*

Before the discovery by Bacon of the true method of philosophizing, by the means of experiment and induction, *authority* presided over science, and regulated the opinions of its cultivators. Philosophers were divided into sects, enrolled under the banner of a school, or enlisted as the followers of a chief, whose name they proudly bore, whose doctrines they blindly espoused, whose volumes they consulted as oracles, in which truth alone could be discovered, neglecting its only source, the great volume of nature. In this light were regarded Pythagoras and Zeno, Socrates, Plato, and Aristotle, amongst the ancients; Descartes, Leibnitz, and Newton, of the moderns.

In medicine this slavish obedience to authority was equally prevalent. The despotism of Galen ruled through no less a period than fifteen hundred years, during which the only liberty a writer dared to assert, was a commentary on his works, and the boldest flight of genius, an extension of his doctrines, or a modification of his principles. When this domination was overthrown, it was for no other purpose than to supplant it by another, changed in name and in form, but of the same character.

Philosophy and physics have been freed from the jargon of the schools; and the cant of logic, which so long imposed the mask of ignorance for knowledge, and the gloss of error for science, has been exposed and discarded. The chains of authority have been broken by the genius of Bacon—*magnus autoritatis contemptor, osorque*—and philosophers clearly understand that knowledge is to be acquired in no other manner than by laborious investigation, and that to be acquainted with the truths of nature, they must be extorted by the painful labour of experiment, analysis, and close induction.

Unhappily this conviction has not been sufficiently impressed on medical philosophers, and *authority* continues in our science to shed abroad its disastrous influence. It has retarded, and must continue to shackle the progress of our science, and opposes,

* Philosophy of the Human Mind.

while adhered to, a most formidable obstacle to its improvement. So long as opinions, precepts, and practical proceedings, are received on *authority* alone, they can be tested, their truth and correctness can be determined only by corresponding authority. But the young and inexperienced will always defer to the authority of those elder than themselves, and more elevated in the profession, and it is only after years of repeated failures, and dearly purchased experience, that they reach the conviction that the authority on which they had implicitly relied, had been a false guide directing their steps astray. But how is the error retrieved —by substituting their own opinions as authority, or embracing that of some other, with no firmer footing, exposed to the same deceptions and fallacies, as that which is abandoned. Hence it has resulted, that under the guidance of authority, the course of medicine has ever been, and must continue to be, halting, uncertain, vacillating, and irregular. Authority has done little more in science than to accumulate around its threshold, the rubbish of error, concealing its entrance, and debarring from its access.

But when authority is discarded, and induction and analysis, or positive philosophy, preside over science, facts take the place of opinions, phenomena are attested where assertions were pronounced, substantial theories replace hazarded hypotheses, and practical proceedings, guided by principles, follow a rational method, instead of a routine enjoined by arbitrary dicta. By appealing to reason, and referring every thing to investigation, all take the same level; the shroud of mystery is torn away, the master, clothed with no imaginary importance, may be judged by the pupil, truth cannot long be obscured, and the reign of error is of short duration. The march of improvement is onward, for an error positively refuted cannot be again resumed. In medicine, truth must be investigated in the same manner as in chemistry, physics, and mathematics, by the experimental, analytic, and inductive method, applied to all the objects of its inquiry and research. In this manner general conclusions can be ascertained, and when these meet with the confirmation of repeated experience and diversified observation, they may be adopted as principles capable of a safe and sound application—it is knowledge, as far as knowledge can be acquired—it is truth, as far as our faculties enable us to pene-

trate the truth. It is this method which has been attempted, though imperfectly, in this work, and the introduction of which, in medicine, it is the design of the writer to advocate and adopt

The systems of practical medicine of the present period may be referred to three classes, as constructed on different methods or principles:—1st. Symptomatic medicine, in which groups of symptoms constitute diseases, and exclusively furnish the indications of practice. 2d. Organic medicine, in which diseases are treated in reference to special organs and particular alterations of texture: and 3d. Physiological medicine, in which the modifications of the physiological or vital action of the tissues, the abnormal reaction of organs, are regarded as the essential character of disease, and the guide to their treatment.

Each of these systems possesses its advocates. The first is allied intimately with ontological views of diseases, and is followed chiefly by the British, many German, Italian, and French physicians, and is chiefly in vogue in the United States. It has, notwithstanding, serious defects. Symptoms do not constitute in themselves a basis of a sound or safe method of practice. They are the signs, addressed to the senses, of the abnormal state or sufferings of the organs, but do not instruct us as to the nature of the change that has ensued, which constitutes the disease. The symptoms too are often delusive, being expressed in other organs than those the true seat of disorder. In spasms, convulsions, and paralysis, the muscles exhibit the symptom or manifestation of the disease, while it is seated in reality in the nervous centres excitative of muscular contraction, and may even be communicated only secondarily to these, having its location in other tissues. Numerous other similar instances might be adduced to prove the fallaciousness of symptoms, taken exclusively for the formation of correct doctrines in medicine, or guides to a safe and judicious practice. Symptoms being always effects, must be referred and traced up to their causes—the organ and the condition of the organ whence they proceed—in order that they may be understood, and that just conclusions be deduced from them. But for this purpose full and adequate instruction is required in the structure or anatomical composition of the organs, and in their physiological offices or vital functions. Without this knowledge, symptoms, which are

the language of suffering or of diseased organs, the expression of the abnormal reaction of the organism, are addressed to those ignorant of their meaning, and incapable of comprehending their import. The uninformed vulgar can perceive the symptoms of disease as well as the physician, but it is the instructed physician alone, who can appreciate their meaning, obtains from them correct ideas, and acts on them with certainty for the attainment of beneficial ends. Symptoms are the instruments by which a knowledge of disease is to be acquired, by which it is recognised, but they are not the disease itself, nor do they compose the knowledge of the disease. Symptomatic medicine approaches closely to empiricism.

Organic medicine is of modern origin. It has grown out of the extended and successful cultivation of pathological anatomy, which has shed so much light, in the present era, on the seats and nature of many diseases, respecting which the most vague ideas formerly prevailed. From the immense advantages conferred by the arrangement and management of the numerous hospitals of Paris, this branch of medical science has been carried to a higher state of perfection in that capital, than in any other city. It is there that the doctrines of organic medicine chiefly are advocated, and from which have emanated so many admirable publications, illustrating the organic characters of disease; works which will ever remain monuments of the zeal, industry, research, and ability of their authors. Organic medicine in France can boast of the names of Bayle, Corvisart, Laennec, Bichat, Bertin, Rostan, Gendrin, Andral, Bouillaud, Louis, Boisseau, and Cruveilhier. In Britain, Abercrombie, Hope, Bright, Craigie, and Forbes, have commenced, and Baillie pursued the same career; while Sœmmering, Lobstein,* Meckel, and Otto, are its cultivators and supporters in the medical science of Germany. Why cannot this list of honourable and distinguished names be enlarged by those of American physicians, successfully improving and contributing to this

* The treatise of Lobstein on the Structure, Functions, and Diseases of the Human Sympathetic Nerve, has been lately translated from the Latin of the original, by Dr. Pancoast, and published in this city. He has enriched the text with a number of notes, embracing sound and judicious views. It is a work which should be found in the library of every physician.

important and advancing department of science? Professor Horner, of this city, can alone be cited as having, in a methodical publication, directed attention to this subject. Had the gifted and indefatigable Godman, my estimable friend, whose memory recalls so many regrets, and whose early loss must be deeply deplored, been permitted to continue on his course, to which he had given this direction, there would have been less cause to reproach, in this respect, the lagging science of our country. But our greatest evil lies in the paucity of our hospitals, and the miserable management, as it regards the great interests of science, under which they are placed. Until the facilities of investigation are freely granted to the medical profession in these institutions, organic medicine cannot flourish in this country, nor can important contributions of positive knowledge, derived from pathological anatomy, be offered for the improvement of the healing art. It is the public, not the profession, however, that suffers the most immediately from the present ill-judged arrangements, and pays the penality of an adherence to antiquated errors, and the propagation of false views of the nature and treatment of disease.

Organic medicine demonstrating to the senses by autopsy the tissues and organs concerned in disease, and the alterations of structure they have suffered, possesses, in this respect, nothing vague or indefinite. As far as it goes its facts are positive, the knowledge it imparts is certain, yet it is defective. It teaches that which is true, but it is not all the truth. The alterations of structure it reveals are effects; they have been preceded by an antecedent cause, which is essentially the disease. Organic alteration of structure being once accomplished, our means of restoration to the natural state are feeble, limited, and not often successful. The physician must anticipate this event, and to do so with certitude and effect, he must be able to penetrate to a knowledge of this cause, to expose the nature of its action, and determine the characteristic features of this phenomenon, which is entirely physiological. Organic medicine conducts to this knowledge; it must precede and prepare for the reception of physiological medicine. When the various alterations of the organic elements, tissues and organs, are disclosed, and traced through the series of their successive stages, the difficulty of arriving at the first or commenc-

ing fact of the series will almost entirely disappear—and we then reach the proximate cause of disease. Organic medicine as a system, exclusive of physiological principles, leading to no clear indications of treatment, it is to be apprehended, may be obnoxious to the reproach maliciously insinuated by the enemies of Hippocrates against his treatment—that it *was a contemplation of death.*

Physiological medicine has more ambitious pretensions. It attempts to divine the nature of disease, by the discovery of the nature of the vital actions and phenomena—the reaction of the organism to impressions—the laws these follow, and the mutations to which they are exposed and suffer, in which last consist the essential character of disease. From these data are inferred positive methods of treatment, calculated on the actual phenomena of disease, the powers and modifying influences on the organs of remedial means. Physiological medicine is unquestionably established on the best method, but its claims to implicit confidence cannot be allowed while physiological knowledge remains imperfect.

Most systems of medicine have been truly physiological. Those based on the vicious humoral pathology, the chemical, mechanical, and physico-chemical doctrines, were all erected on the prevalent physiological ideas of the time; but, as these were no more than suppositions, the doctrines themselves were mere collections of hypotheses. The theory of Hoffman, and its modification by Cullen, were of the same character. Brown made an auspicious commencement; he struck out a mother-thought fruitful in its applications; he opened the route, which, most probably, must be followed in the pursuit of this investigation; yet so utterly destitute was he of correct anatomical and physiological information, that every subsequent step was but a series of errors. Darwin and Rush, better instructed than Brown, adopting his first principle, formed systems of greater truth, of more extended application, conducting to more just conclusions and of happier tendencies in practice. But they could not resist the influence of the time in which they lived. Their materials were most defective; the physiological and anatomical facts they were compelled to employ were imperfect—not adequately authenticated—too frequently

hypothetical: analytical anatomy was unknown in England and this country, and pathological anatomy had received no methodical cultivation. Surrounded with these difficulties, their genius could not emancipate them from errors fatal in their consequences; and, though their doctrines will ever be esteemed as monuments of powerful intelligences, they can be regarded in no other light than as approximating gradations in the advance of truth.

Broussais has been more fortunate in his time. Every department of medical science has been pressed forward with a zeal, industry, and talent, never before equalled, and in methods of superior order. The improvement has been corresponding. Analytical anatomy is established, and advances rapidly to perfection. Pathological anatomy, to which he gave so powerful an impulse in his Chronic Phlegmasiæ, assumes daily a higher influence, while physiological investigations, prosecuted in the spirit of a strict philosophy, are unravelling the mysteries of vital and functional phenomena. The doctrine of Broussais, evolved by his extensive pathological researches and clinical observations, combined with a method often of rigid induction, allies the principle of Brown with the general anatomy of Bichat. This doctrine, in its fullest extent, can be considered, however, as no more than *the physiology and philosophy of irritation.* This great and extended phenomenon, productive of so many and diversified consequences, he has appreciated more clearly, and more fully developed, than any who have preceded him. His system is, however, but partial—it is not universal. Physiological knowledge lies far in the rear of that state of perfection to which it will arrive; the mysteries of vital phenomena, the laws of vital activity, no one can pretend, are spread before us in a blaze of light, leaving no doubts, no hesitancies, no difficulties, as to their nature. For no system of physiological medicine can, then, be claimed the attributes of infallibility and perfection. The system of Broussais contains many and important truths; but it is not all true, nor does it compass all truth. It is enforced by its author in too dogmatical a spirit.

In the present state of medical knowledge, the wisest course of proceeding is, probably, to generalize with a cautious spirit, under the guidance of analysis and induction, all the facts of medi-

cine, reconcileable with a fixed principle substantially based, or a universal phenomenon; thus forming a philosophical eclectism, freed from a blind adherence to any one system—*Tros Rutulusve fuat.* This course has been attempted, though executed feebly, and it may be, with a failure, in the present work. Composed at snatches in the uncertain intervals of a hurried and fully occupied life, without the opportunities of revision and correction, and frequently under the acute suffering of a painful affection, many imperfections must exist. Should it tend to impart a better direction to the pursuits of the medical student of this country, for whom it is intended, the object contemplated by it will have been attained.

In the preparation of this work I have freely drawn for materials on various writers. In this list I may enumerate, as the principal, Haller, Bichat, Beclard, Broussais, Adelon, Gendrin, Andral, Meckel, Bell, Wedemeyer, Begin, Bourdon, Tiedemann, and the different journals of the day.

THE

PRINCIPLES OF MEDICINE.

CHAPTER I.

A VERY cursory examination of the objects of nature, is sufficient to demonstrate the existence of two great divisions having few or no correlative points, but standing opposed to each other in almost every characteristic trait.

Matter or the constituent elements of the universe, may be divided into two kinds; inorganized, brute or dead matter; and organized or living matter. Unorganized matter is subjected to the forces whose generality of action, constitutes physical and chemical laws; organized matter is influenced by the same forces to a certain extent, but is especially characterized by another and entirely different force, or power, whose generality of action, composes the vital or organic laws, or laws of living matter. In organized matter, vital laws hold supremacy, and control those of physics and chemistry, which they modify and render subservient, on many occasions, to the purposes of vitality.

In both these extensive divisions, matter in its ultimate elements is the same, but differs entirely as to its forms and properties; they are infinitely more numerous in unorganized, than in organized matter. The duration of the forms that matter assumes, and the properties it acquires in its inorganized state, is indefinite; they may exist from a few moments to a thousand ages. But in organized matter its forms and properties have a limited existence; a period is allotted to each, beyond which it cannot be continued.

These two divisions of matter differ further in many other important particulars, which in a regular treatise on physiology, it would be proper to describe. It will be sufficient for our pur-

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poses, to designate in a general manner the prominent points in which they contrast with each other.

Inorganized and organized matter differ, first, as to composition, and form; second, chemical nature and interior disposition, or molecular arrangement; third, in their origin or primary formation; fourth, in the mode of conservation or existence; and lastly, in their termination or end.

From the great diversity that in so many respects signalizes inorganized and organized matter, they diverge to the most extreme points, and their consideration forms totally distinct branches of pursuit or studies. The forms, the forces, and the laws of inorganized, or dead matter, are the subjects embraced in physics and chemistry; the forms, the forces, and the laws of organized, or living matter, are the object of the physiological sciences. Of the sciences occupied in the investigation of nature, physiology may claim the highest rank; it embraces in its researches the larger proportion of the bodies of the universe; it is engaged in observing and unfolding phenomena of the most elevated order; and which belong to the most elaborated and perfected of the works of creation.

Having enumerated the differences that exist between inorganized and organized matter, this last is to be noticed in its general relations.

It has been said, that the forms and phenomena of organized matter, are the objects of physiological research; physiology may be defined the science of life. Taking in its scope so extended a field, it is susceptible of several divisions. When confined solely to the general phenomena of organized beings, treating in an abstract and philosophical manner, the phenomena of life, it constitutes general physiology. These beings are, however, of very different nature, forming two extensive divisions of organized matter, vegetable and animal. Physiology, as it is engaged with the vital phenomena of vegetables and animals, is named vegetable or animal physiology, and when occupied with that of a single species, it is called special physiology, as of the elephant, the horse, &c.; when devoted to man it is called human physiology.

Sect. I.—*Of Organized Bodies.*

The peculiar and essential characters of organized beings, are first, they commence their mode of being by a generation, that is, they proceed from a molecule that has previously belonged to another being similar to themselves, and after certain developments they separate at epochs of fixed recurrence from the parent, or, as it may be expressed, they have a birth; second, they are developed after a determinate type, from which there can be but inconsiderable deviations; third, they have the power to maintain themselves by the appropriation and assimilation of exterior matter to their own substance, or to conserve themselves as individuals by a nutrition; fourth, they preserve themselves by their inherent forces and recuperative actions, to a certain extent against the causes that tend to their destruction; fifth, they continue their species or race by a reproduction; sixth, they have a limited existence, during which they pass through certain stadia called ages, and terminate by a death.

The whole of these acts constitute life, and are the result of motions or actions of which organized matter alone is susceptible. In what manner organized matter acquires its susceptibility for these actions is unknown, but when it is once acquired, those actions are excited and continued by the impressions of external agents, called stimuli. The capacity or aptitude for vital phenomena may exist, but without the impression of stimuli to call them forth, they remain quiescent. This fact or principle is exemplified in the seeds of plants, and the ova of oviparous animals. The first will not germinate without the combined influence of heat, moisture and oxygen; and the last require for the excitement of their vital movements, heat and oxygen.

Life is then, as was announced by Brown, called into activity and maintained by stimuli, or is the consequence of the operation of stimuli or excitants, on organized matter.

The recognition of this principle is of the highest importance. It is the first element of every problem, involving considerations of vital phenomena, and must be the starting point of all our reasonings on the animal economy, the functions of the organs, the modifications they experience, and the manner in which they are influenced. It is this principle that renders all the objects of

nature that surround us, or can be made to act on our systems, as heat, light, electricity, magnetism, the air, our food, drink, clothing, medicines, and other remedial means, modifiers of our organs, and the organic actions. Hence these causes, exceedingly different in their nature, have, notwithstanding, the same general modes of action on the organized structure, either exciting or diminishing the organic actions of the organ or organs receiving their impression; they are stimulants or sedatives. All the recognized phenomena of physiological or pathological life, may be explained on these two different modes of action, as occurring in structures of different nature and functions; and all the agents we employ, as far as our researches can be carried, have no other appreciable mode of action. The same causes are, according to the degree of their activity, and the intensity of action they produce, supporters or destroyers of vital phenomena, morbific or healthful and remedial agents. If specific modes of action do exist, they are unknown, and we can derive no assistance from their admission in explaining the phenomena of the animal economy in a natural condition, or be aided in the adoption of practical means to combat them in a morbid state.

Whether the capacity to be thus influenced by stimuli, is a property matter acquires by its organization; or whether it proceeds from an immaterial or imponderable principle, acting through organized matter, is a question of metaphysics entirely foreign to medicine. Our science has regard only to demonstrable facts.

What we know as certain, is, that organization and vitality are inseparable; they cannot exist in an isolated state. Of vitality we can form no conception, but as it is displayed in organized matter; and of organized or living matter, our knowledge is altogether derived from the vital phenomena it displays.

Let vitality then be considered as a property of organized matter, or an immaterial principle, that can act only through material organs, and is influenced by their condition, the result is the same. It is organized matter, its structure, its properties, its actions, and the laws these observe, that constitute the proper object of the researches and reflexions of the medical philosopher and physiologist.

Animal matter assumes three principal forms, gelatin, albumen, and fibrin, which are the remote organic elements of the animal

structure; and which arranged in fibres and filaments, and variously modified, compose the basis of its different tissues, organs, &c. Each of these forms does not enter into the composition of every class of animals; they are not to be found indiscriminately in every tissue, or organ; and do not manifest the same vital phenomena.

Animals of the lowest class, as polypi, &c. are composed entirely of gelatin. Their organization and vital phenomena are of the simplest order; they possess neither organs nor vessels; they are formed of a single tissue; possess a single function, nutrition; and offer only a single manifestation of vitality, contraction.

Ascending in the animal scale, fibrin and albumen are superadded; the animal organization is more complicated; vessels, numerous tissues, and organs variously composed, exist; and the vital phenomena are multiplied.

Man placed at the head of the zoological scale, presents the animal organization in its most perfect condition. His organism is its terminating point. He includes every structure of the inferior grades, and is the accomplishment, the complete development of the uniform type, that presides over the organization of the great class of the vertebrated animals. In prosecuting physiological investigation, our attention must not be riveted on this perfected structure. We must interrogate vital phenomena and examine organized or vital structure thoughout organized beings, from complex man to the simple spongiaria and monad, and the vast kingdom of vegetable existence. It is in this manner alone, we can acquire correct and determinate information, on the organic or vital structure and actions of the human system itself.

Having taken this hasty survey of organized beings, and the general characters of organized matter, we are now prepared to enter upon the study of the human formation, and the physiological history of man.

Sect. II.—*Analytical, or General Anatomy.*

Anatomy is defined to be the science of organization. It consequently embraces all organized beings, and is divided into phytotomia, or vegetable anatomy; and zootomia, or animal

anatomy. This last comprehends zootomia proper, or comparative anatomy, and anthropotomia, or the anatomy of man.

A further division is descriptive or special anatomy, which is occupied with the particular description of the form and relations of each separate organ or tissue; and general anatomy, which treats of the composition, disposition, and functions of the different tissues common to many organs. For this last, which is entirely of modern origin, we are indebted to the genius of Bichat, who, seizing on the ideas emitted by Bordieu, Barthez, and Pinel, extended them into a beautiful and comprehensive doctrine. This department of anatomy should engage the constant attention of the physician. It is the source whence are derived all sound principles and correct views, in physiology, pathology, therapeutics, and practice.

A very slight knowledge of animal organization, is sufficient to show, that in the higher classes, it is a compound, into the composition of which enter very different structures, having only a general analogy in their elements, form, properties, and function. The ultimate organic animal elements, are the same in all the structures, but the proportions and form vary, and to each change of proportion and form, is attached a difference of property and function.

The human organization is to be studied then, as a compound structure, consisting of various remote and proximate or immediate animal elements, or principles, whose reunion into different forms, compose the tissues, organs, apparatus, and systems of the animal economy. To acquire definite and clear ideas of the condition of its existence, it must be analytically examined; decomposed, as it were; and each of its elements separately considered.

The remote animal organic elements, gelatin, fibrin, and albumen, exist in two states, solid and fluid, forming a fixed animal, and moveable animal matter. Between these, during life, is maintained an incessant action; they are mutually dependent on, and convertible into each other. With the addition of some other elements, as lime, sulphur, phosphorus, iron, some alkalies, &c. they constitute the human structure.

The fluids exceed in quantity the solids; the precise proportion

between the two cannot be exactly determined. It must vary with different individuals, but may be taken at a medium as nine or six is to one.

The blood is the principal of the fluids. It is constantly renewed from without; contains all the other fluids which separate from it, and gives origin to the solids. It has been appropriately named liquid flesh.

The solids assume determinate forms and consistency, in each texture and organ. They are the seat of the vital properties, and movements. Consisting of one or more of the organic animal elements differently combined, and their molecules variously arranged, they are extended into fibres, spread out into membranes, moulded into vessels, disposed into globular, or vesicular and areolar tissue; every where interstitial, though in different degrees, they are every where more or less permeable to the fluids; they are soft, or firm, contractile, extensible, or resisting. All the organs, all the different tissues are thus composed in variable proportions of solids and fluids. The first impart the form, the peculiar character of the texture, the consistency, volume of the organs, &c. They contain the fluids, and between the two exist movements, whence result nutrition in health; unnatural formations in disease, and the separation of each particular fluid by special organs, constituting the secretions and excretions, both natural and morbid.

As the organism is thus composed of parts that contain—the solids; and parts that are contained—the fluids, it has been supposed that the solids consisted entirely of vessels. This cannot, however, be true of the vessels themselves; besides nutrition, the composition and decomposition of the body, cannot be accomplished while the blood is retained in columns in the vessels. For the performance of this function, which is a molecular action, it is essential that the blood should pass from them, that it move in the interstices, and amongst the globules and molecules of the fixed animal matter, every where porous, that its molecules may be in immediate contact with those of the solids.

These cannot, therefore, be considered as a mere assemblage of vessels. Besides, repeated microscopical observations have shown satisfactorily, that the ultimate animal organic structure is vesicular or globular, in almost every tissue. There is even

some foundation for regarding these globules, as atomic particles of animal matter or organic atoms. Nothing is more evident, in attentively examining the circulation by the microscope, but that it is carried on in channels formed in the minute globular structure, and not in tubes or vessels. But of this hereafter.

The solids may be separated by mechanical division into fibres, and these again into other fibrils almost indefinitely. It was concluded from this circumstance, that a single elementary fibre, which was the last filament that could be conceived of, formed the basis of all the solids. The cellular tissue was conjectured to be its first product, of which all the different organs, it was believed, were composed. This doctrine of a single elementary fibre has never been, and never will be demonstrated. It is to be considered as a mere mental abstraction. The late microscopical observations alluded to, made by Prochasca, Brodie, Home, Edwards, Dumas, and Dutrochet, have clearly demonstrated that the animal fibres are formed of globules, consecutively arranged, and derived from the blood; they are the same as the globules of the blood.

Accurate microscopical examinations have demonstrated the remote animal matter, gelatin, albumen, fibrin, to present itself in the animal structure under two forms, that of globules and an amorphous, coagulable, or coagulated substance, assuming the first state in the fluids, and both in the solids; these may be termed the ultimate animal organic elements. They do not necessarily exist together in all the fluids and solids; but the globules are never found alone; they are always accompanied with the coagulable or coagulated substance, in which they are enveloped. From the researches of Dr. Milne Edwards, it would appear that the elementary constituents of the different tissues, cellular, fibrous, vascular, muscular, and nervous, never vary; each preserves a perfect identity in all animals. It would also appear, that the globules of which they are immediately formed, are uniform in all the tissues, and in the same tissues in all animals as to size and form; whence it may be concluded that they affect a primitive and determinate form. An additional reason is furnished by this observation, for regarding the globules found in the animal structure, as the atoms of animal matter.

A very singular fact is established by Prochasca, which lends

a confirmation to this view. Having macerated some portions of brain, during six months it was totally changed in its structure, and disorganized by this process. He found, however, the globules were perfect, though no longer adherent. Putrefaction, that had destroyed the structure of the brain, had not affected its elementary globules.

The animal organic elements, the globules and coagulable substance assume two principal forms, the fibrous and laminary. The first is common to the coagulable fluid and the globules, either separately or conjoined. Thus in bones, tendons, &c. the coagulable matter is reduced to the fibrous form. In nervous substance and in muscles, the globules consecutively arranged and united by the coagulable matter, without which they cannot acquire consistency, also, present the same form. The laminary form is always composed of the coagulable substance alone, as in the serous membrane, cellular membrane, &c.

Sect. III.—*Of the Solids.*

From the animal organic elements differently combined, proceed the organic solids of the body, or those parts by which its form is determined, and its movements are accomplished.

The number of the solids is not exactly settled by anatomists. The following enumeration may be considered as nearly complete. 1. Cellular, areolar, mucous or laminar tissue. 2. Vessels, distinguished by their offices, as arteries, veins, capillaries, and lymphatic vessels. 3. Nerves. 4. Membranes. 5. Bones. 6. Cartilages. 7. Fibro cartilages. 8. Ligaments. 9. Muscles. 10. Tendons. 11. Aponeuroses. 12. Glands. 13. Follicles or cryptæ. 14. Viscera. 15. Lymphatic ganglion. And 16. The corneus tissue.

The preceding solids are not simple in structure, but are compounded, and are to be reduced into a certain number of immediate elements, which have been named tissues by Bichat, to whom we are first indebted for this mode of classifying the organization.

The tissues may be regarded as proximate or constituent organic elements, into which the solids are resolved in a first anatomical analysis; in a second we are presented with the fibrous

and laminary structure, which consists, as has been shown, of globules, or vesicles and coagulated substance; and these are composed of the remote animal elements, gelatin, fibrin and albumen.

The solids in reference to their functions in the economy, each acting in its own manner, are called organs, and the animal economy to express the concurrence of the vital actions, is named organism.

The organs have each a particular office to execute. They are notwithstanding associated into groups; each reunion being charged with the performance of a special function. Bichat very happily named this combination of organs *appareils*, which may be translated by the English word apparatus; though it does not convey the precise idea of the French term. Thus we have the apparatus of digestion, of respiration, &c.; that is, all the different organs whose conjoined actions accomplish the function of respiration, digestion, &c.

The tissues or proximate animal elements, of which the organic solids are composed, have received the name of systems, being met with in different parts of the body, and in different organs. Various classifications of the tissues or systems have been attempted; most of them are modifications of that originally proposed by Bichat. This celebrated physiologist divided the systems into two great classes—general or generating, as he named them; and particular systems. The first are distributed throughout the economy, enter into the composition of all the organs, precede their development, forming their outline or canvass, which is to be filled up by the product of nutrition, and carry into every organ, however complex its structure, their peculiar mode of vitality or functional action. The predominance of any one of these systems in the general organization or particular organs, forms the basis of the individual temperament, modifies the effects of external agents, influences the healthy actions of the organs, and the phenomena of disease. When treating of the temperaments we shall have occasion to refer more particularly to this circumstance.

Bichat made seven general systems, but they may be reduced to three—the cellular; the vascular, including arteries, veins, capillaries, and lymphatics; and the nervous.

In the second class or particular systems, Bichat placed four-

teen tissues or systems. They are composed of some, or all of the general or generative systems, in various dispositions, proportions and numbers, combined or incrusted with special nutritive substances—hence he named them compound systems.

Originating this species of classification, Bichat carried it to excess, and multiplied his divisions unnaturally. Most physiologists have, since the appearance of Bichat's General Anatomy, modified his classification, and proposed one of their own. The differences between them, as respects the more important tissues, are trifling. The twenty-one systems or tissues of Bichat, may then be reduced to the following—

1. Cellular. 2. Vascular, (arteries, capillaries, veins and lymphatics.) 3. Serous. 4. Fibrous. 5. Fibro Cartilaginous. 6. Cartilaginous. 7. Osseous. 8. Nervous. 9. Tegumentary. 10. Glandular. 11. Muscular.

The serous and fibro-serous tissues, and probably fibrous, might be included under the cellular, of which they appear to be modifications; but in making the tissues or systems the basis of a pathological arrangement, it is more conducive to clearness and precision, that the tissues spoken of, should be kept distinct.

In almost every physiological, pathological and therapeutic problem, the medical philosopher is called on to solve, or disquisition to enter upon, a reference must of necessity be constantly made to the tissues, as the immediate elements of the organs, and the seats of the organic actions, whether natural, morbid, or therapeutic. It will be therefore requisite to give a general view of the characters, dispositions, structures and functions of the principal tissues—those that enter into the composition of the most important organs, and are most deeply involved in every physiological and pathological phenomenon.

Sect. IV.—*Cellular Tissue.*

This tissue, of a white colour, spongy and soft texture, is diffused throughout the body, uniting its various organs, between which it is interposed, surrounding them and penetrating into their interior, thus concurring in their structure. So diffusively is the cellular tissue spread throughout the system, that could it be presented in a separate state, it would offer the general

configuration of the body.—It is the basis of all the tissues and solids.

In its structure it is lamellar and filamentous, whence it is disposed into permanent, irregular and variable areolæ, having a free communication with each other.

In a healthy state it does not appear to possess sensibility, but is endowed with irritability, and is susceptible of manifest vital contractions.

The cellular tissue is the seat of a serous exhalation, by which it is continually moistened. The suppleness and elasticity it acquires in this manner, facilitates the movements of the organs and contiguous parts on each other. It constitutes an essential membrane for each organ, enveloping its minutest particles, and determining its form and size. In this manner each organ is isolated, to a certain extent, by the cellular membrane, from all other organs; is abstracted, and in some measure defended from the diseased actions, existing in contiguous parts.

The cellular tissue interests us on pathological considerations. The serosity that lubrifies it often accumulates, or is unduly secreted. The tumefaction induced is named œdema when local, anasarca when it is general—it is also penetrated by air in consequence of wounds; and gases are secreted into it, whence is formed the species of infiltration named emphysema.

The cellular tissue is attacked with inflammation, which takes in this tissue the name of phlegmon. It may be limited, when it forms a furunculus or anthrax; or diffused, as in erysipelas phlegmonides, when that inflammation penetrates into this tissue.

The acute inflammation of this tissue, is sometimes productive of secretion of lymph or gelatin. The tumefaction is then renitent, and does not pit on pressure. It is accompanied with great soreness, and even pain, especially on pressure.

Inflammation of the cellular tissue often possesses a sub-acute state and gives rise to the secretion of a concrescible or albuminous matter, and a species of alteration is induced, that has been named white induration. Analogous to this is elephantiasis.

An affection peculiar to infants occurring in the first months after birth is seated in this tissue. It is the scleroma or hardening of the cellular tissue of new-born infants. It is a diffused sub-inflammation by which a secretion of yellowish fluid is produced in the cellular areolæ.

This tissue forms the base of some accidental tissues, as polypi, fungi, kysts, &c. They are the result of a chronic irritation, changing the mode of its nutrition.

Sect. V.—*Vascular System.*

The vascular system consists of membranous tubes or vessels, connected together in an aborescent form, and traversed by fluids destined to nutrition, and to the secretions.

Three orders of vessels compose this system; arteries and veins that carry blood, and lymphatics which transport lymph and chyle. The whole of these vessels, with the heart, compose the apparatus of the circulation. The heart is the point where are united the large vascular trunks, which divide into numerous branches as they are removed from it; but the sum of the caliber of the branches taken together, is greater than the caliber of the trunks whence they proceed. The circulatory system forms in this manner a cone, of which the heart is the point, and the smaller vessels the base. By this disposition, the resistance to the passage of the blood, into the smaller vessels, is so much diminished, as to be scarcely felt as an obstacle.

All organs have not the same degree of vascularity, or vessels of the same description. Those that are furnished most richly with sanguine vessels, are the lungs, the tegumentary system, pia mater, choroides, glands, follicles, cortical substance of brain, nervous ganglions, muscles, &c. Those that possess the most lymphatics, are the lymphatic ganglions, serous membranes, cellular tissues, and glandiform bodies. In cartilages and dependents of the skin, no vessels have been discovered.

The sanguine vascular system is composed of three parts. 1st. The arteries. 2d. The capillary system of vesssls, which differing in properties and functions from the larger vessels, may with propriety be regarded as a separate system. And 3d. The veins.

§ 1.—*Arteries.*

The arteries conduct the blood from the heart by which it is propelled into the capillary vessels. They possess very little if any sensibility, and the possession of irritability has been denied to them by Haller, Nysten, Bichat, and Magendie.

The arteries are formed of three tunics; an external cellular, a middle fibrous or proper coat, belonging to the yellow elastic fibrous tissues, and an internal membrane that appears to be a serous tissue.

The two first certainly cannot possess more than the low degree of irritability, or excitability, natural to the system of tissues to which they belong. The internal membrane, on the contrary, is undoubtedly highly irritable, as the serous tissues are, and is interesting to the pathologist as the frequent seat of inflammatory irritation. This membrane is continuous from the arteries to the left heart, the cavities of which it lines, and by its duplicatures forms the valves existing at the openings of this organ.

In fevers characterized with malignant symptoms with extreme prostration, this membrane is found in the heart and large vessels highly inflamed. It sometimes exists in this state, but of limited extent, and of slighter degree, in the close of fevers, maintaining for a considerable period, a febrile irritation and protracting convalescence. In those cases in which mercury freely exhibited with a view to induce salivation, acts as a poison to the system, it is this membrane which suffers most commonly, and is found to be extensively inflamed, especially in the heart. It is also subject to the usual effects of inflammations, such as ulceration, thickening, effusion of lymph, &c. Excrescences or vegetations of the valves of the cardiac orifices, conversion into osseous tissue, &c. are also the result of its irritation.

Pinel formed an order of fevers founded on the inflammation of the arteries, which he named angiotenic; and is synonymous with inflammatory fevers.

§ 2.—*Capillary System.*

The capillary vessels, so named from their extreme minuteness, (capilli,) are profusely distributed throughout the interior of the organs. They are usually regarded, and studied anatomically, may be considered as the last ramifications of the arteries, and the first radicles of the veins; no line of demarcation can be drawn between them on structural principles. Physiological and pathological facts demonstrate, however, differences so considerable in their modes of action, in their vital forces and functions, that we have a right to infer a difference of structure. The capillaries are the most irritable of all the component parts of the organism, and

the irritability of any organ is in proportion to the amount of its capillary tissue. They possess in an eminent degree a vital action, and are capable of carrying on their circulation, to a certain extent, independent of the heart by forces inherent in them. The capillary system may be regarded as an antagonist to the heart; it receives the blood propelled by this organ; which after having served the purpose of nutrition, it re-propels back again into that organ through the veins. In the larger vessels, on the contrary, irritability in the proper coat, has a very feeble existence, and it is a subject of controversy, at this day, whether they possess this property in an active degree. They are little more than elastic tubes or conduits, transmitting the blood between the respiratory capillaries of the lungs, and the general capillaries, by means of the active force of the heart, placed intermediate between the two.

The capillaries ramify and anastomose to infinitude. They form a close compacted net-work, or rather an immense reservoir with endless divisions, in which the blood moves not in one uniform current, but according to the demand made by the necessities of any particular organ or part. This demand is always an increase of the organic actions or movements, or in other words, an irritation, either caused by external, natural, or artificial irritants, or by the internal vital irritants that influence the organic actions.

The last degree to which the capillaries ramify cannot be determined. The finest that can be observed by the microscope is the size of a globule of blood.

From the result of microscopical examinations, little doubt rests on my mind that a large proportion of what is regarded as capillary circulation, is not in fact performed by vessels. On the contrary the blood circulates out of vessels, but in currents, which are established in the globules and interstices of which the ultimate structure consists. While examining the circulation in diaphanous tissues, we have the ocular demonstration of this fact. The currents of globules flow in every direction; I have seen currents of globules commence where none existed, and by the application of a mechanical irritant, I have seen the whole tissue become a mass of moving globules, pursuing every course with great diversity in their velocity. Dutrochet speaking of the circulation of the salamander, mentions that he has seen the glo-

bules suddenly strike off laterally into the surrounding structure. He could not account for the manner in which they could thus escape, from the vessels, though he declares he has observed the fact too often to permit a doubt as to its existence. There is no question that the observation is correct, and is an additional evidence that the blood is not confined in closed vessels or tubes.

The capillary or molecular circulation, is the principal agent concerned in the organic actions and most of the vital phenomena. In it occurs the molecular or atomic movements, by which the vital actions, sanguification, nutrition, calorification, secretions, &c., are performed. It is the seat of sanguine irritations, congestions, hæmorrhages, effusions into the interstitial structure of organs, either sanguine, constituting apoplexies, ecchymoses, petechiæ, red induration, carnification, hepatization; or of serous and albuminous effusions, forming dropsies, tubercles, white indurations, &c.; in fine, of nearly all the morbid phenomena depending on the vascular system. Thus extensively concerned in the healthy and morbid states, the capillary system should occupy the close attention and unremitted study of the medical practitioner.

The capillary system throughout the economy is every where connected, and contains within it the great mass of the fluids. A violent disturbance of its actions in any one part is felt to a greater or less extent in other parts; and sometimes the functions of the whole are deranged. The blood, called by excitement into a portion of this system, and accumulated there unnaturally, is derived from other portions, and the capillary system and its circulation is, in this manner, at the same time, in the most opposite states; there is an excess of action and congestion in one part, feeble action and deficiency of fluids in another. By this kind of operation, different portions of the capillary system are in antagonism to each other. Thus the capillaries of the internal mucous tissues antagonize those of the skin; those of the head and upper part of the body, are opposed to those of the lower extremities. Hence it is, that in extreme conditions, one set of capillaries is accompanied with, and productive of the reverse state of the other set. Violent internal inflammations and congestions occasion torpor, asthenia, want of action, and glacial coldness of the external surface; inflammation of the brain, determining the capillary fluids towards the head, are attended with cold extremities, &c.

§ 3.—*Veins.*

The veins are vessels of less compact texture than the arteries, and which give passage to the blood from the capillary system to the auricles of the heart.

The general disposition and structure of the veins are not subjects of interest at this moment. We shall merely designate the lining membrane as having considerable analogy with that of the arteries, though more extensible and resisting. It is continued into the cavities of the right heart and pulmonary system of vessels, and exists alone in the veins of the bones, and in the sinuses of the dura mater.

This membrane, like that lining the arteries, is irritable, and is often the seat of inflammation constituting phlebitis. This morbid condition is infinitely more common than is frequently suspected. It occurs as a consequence of wounds in the veins in bleeding, from surgical operations, from the ligature of these vessels, or of the umbilical cord. It also results from the inflammations of surrounding tissues, and exists as a complication in some cases of fever. Adhesive inflammation occasionally obliterates the cavities of the large veins, and the obstruction induced causes serous effusions that are incurable.

§ 4.—*Lymphatics.*

The last order of the vascular system is the lymphatics. These vessels are an annexation to the veins in which they terminate. They conduct to them a fluid different from that of the veins, being limpid or whitish, but is nearly converted into blood in its course through these vessels. The lymphatics arise by capillary radicles in the intimate structure of the organs and from the surface of the intestines. Fohmann, a German anatomist of reputation, asserts that in fishes, he has ascertained the lymphatics to originate in a cul-de-sac, or by a closed extremity forming a pouch, and not with an open or patulous orifice, as was affirmed by Monroe and Hewson. This fact does not throw any difficulty on their absorbing function, as it is now a demonstrated property of all the animal membranes to absorb fluids.

The lymphatic system is of a reticulated, aborescent form; its vessels anastomosing in an infinite manner, and terminating, some immediately in the contiguous veins, but mostly in two principal trunks. They are found in all the organs except the brain, spinal marrow, the eye, the interior ear and placenta.

It has been contended, particularly by Magendie, that the lymphatics do not absorb, but arise immediately from the arteries, and that their office is to return the white blood into the general circulation. This view of the origin and sole office of the lymphatics cannot be well sustained. It is very probable they do convey the white fluids to the heart, but it is an office not incompatible with their function of absorption.

In the course of the lymphatics numerous glands occur. They appear to be formed by the interlacing of these vessels, and venous vessels that inosculate with them, and of nerves. These glands possess a fuller development, and a more active nutrition and function in infancy, than in other periods of life. It is in consequence of this circumstance, they are so frequently affected with acute and chronic irritation in early life.

The lymphatics and their glands are endowed with a considerable degree of irritability, especially in infants and children. Inflammation of this system is of frequent occurrence. It usually is of a chronic character, and accompanied with peculiar phenomena. It has been erected into a specific disease, under the name of scrofula, supposed to depend on a specific virus. Suppuration, secretion of albuminous matter, obliteration of their cavities, are among its consequences. The glands often are the seat of white induration. Chronic irritations of lymphatics eventuate frequently in the formation of tubercles, more especially in the lungs.

Inflammation of the lymphatics is excited by the direct impression of irritants, as the absorption of irritating matters; by the inflammation of contiguous parts; by the impression of cold, &c. on the surface.

Sect. VI.—*Serous System or Tissues.*

The serous tissue consists of a number of cystiform membranes, independent of each other, and lubrified by a fluid ex-

haled from its free surface, analogous to the serum of the blood; whence the name of this tissue. It may be divided into splanchnic or the serous membranes lining the splanchnic cavities, and into synovial, lining the joints, including the bursæ mucosæ. The splanchnic serous tissues are, peritoneum, pleuræ, lining of pericardium, arachnoid, tunica vaginalis. This tissue may be considered as a modification of the cellular. It is the seat of a serous exhalation, but no vessels are to be detected in it, in a healthy condition. It possesses doubtlessly a circulation of white fluids.

In a natural state the serous membranes have no sensibility, but become exceedingly sensible when inflamed. Their nutrition, secretions and diseases, are evidences of the existence of irritability, and of a circulation.

Serous membrane forms a covering or coat to the organs of the splanchnic cavities, and separates them from each other. Its smooth and polished surface, moistened with a viscous fluid, answers this purpose admirably, and besides facilitates their sliding on each other in the movements of the body. The extent of this system is much greater than that of the tegumentary. Hence may be conceived the importance of its exhalent faculty to the economy.

The serous membranes are attacked by inflammations both acute and chronic, forming diseases of frequent occurrence, and often of difficult cure. Most of the effects of inflammations are to be met in them—effusion of lymph, exhalation of fluids, hæmorrhage, thickening, gangrene, &c. Chronic inflammations form cysts, tubercles, hydatids, white tumours, cartilaginous and osseous concretions.

Sect. VII.—*Fibrous System.*

This system it is necessary to notice only casually.—It is a white shining tissue, argentine and brilliant, very resisting and composed of numerous apparent fibres diverging in different manners.

It exists very extensively in the economy, but is not connected and coherent in every part. It forms the ligaments and tendons. It also serves as an envelope to organs, constituting aponeuroses to muscles, sheaths to tendons, periosteum to bones,

dura mater to the brain and spinal marrow, neurilema to nerves, sclerotica to the eye, albuginea to testicles; and the proper coat to the kidneys.

This tissue, though vessels are not to be detected in it in a healthy condition, is susceptible of irritation and inflammation. It is the seat of rheumatic inflammation. In this tissue inflammation rarely terminates in suppuration, or in gangrene. Chronic phlegmasiæ convert it into osseous and cartilaginous tissue. It also becomes softened and is absorbed, as in old chronic cases of rheumatism, and has developed in it fungous, polypous and carcinomatous tumours.

This tissue is one of the accidental tissues, that occur in the organs to which it does not belong, as a result of chronic inflammation, and a perverted or misplaced nutrition. It often forms in this manner tumours between the rectum and the bladder, and rectum and vagina. In the uterus and ovaries, this species of degeneration is very common, forming fibrous bodies, lodged in the thickness, or in the surface of the uterine walls. It is usually confounded with scirrhus of this organ.

A modification of this tissue forms the yellow or elastic fibrous tissue. This last bears a strong analogy to the fibrous system in its structure, but is distinguished from it by its remarkable elasticity. The organs where we meet with this tissue are the yellow ligaments of the vertebræ; the proper coat of vessels, especially of arteries, of excretory canals, and the bronchial tubes, the proper coat of the spleen, and the corpora cavernosa penis. The fibro-cartilaginous tissue is also a modification of the fibrous system.—Its relative unimportance renders it unnecessary to notice it in detail.

The *cartilaginous* and *osseous systems* offering few or no points that will be requisite in the elucidation of physiological or pathological principles, will be passed by without receiving a particular exposition.

Sect. VIII.—*Nervous System.*

This system holds the highest rank in the animal organism. Varied functions of the most elevated order, are the offices assigned to its actions, and which, both in a physiological and

pathological point of view, are deeply and extensively interesting.

This system is a collection or reunion of organic apparatus, having each especial offices to fulfil, yet the whole constituting a system intimately connected in all its parts, and the functions it performs.

The nervous system exhibits in the most evident manner the two lateral halves that compose the body. Nearly all its parts are doubled, and where they are simple, it is on the median line, along which the two lateral portions are united and appear to be confounded into a single mass. Each half of the body, in its nervous structure, is an exact examplar of the other. The nervous system is then most perfectly symmetrical.

The nervous system consists of the encephalon or brain, and spinal marrow—the cerebro-spinal apparatus, or the central masses of nervous structure; of the nerves or nervous cords, extending from these centres to the organs of the economy; of the nervous expansions or tissues existing in and forming an elementary tissue of the organs; and the trisplanchnic or great sympathetic nerve, or ganglionic nervous apparatus.

Nervous matter is composed of the animal element albumen; gelatin being found only in its vessels, or the membranes that form its envelope. Its structure in its principal characters, is the same in every part; in the brain, spinal marrow and nerve. In a last anatomical analysis, it presents the form of semi-transparent globules, united by a viscous demifluid substance. These globules in the medullary substance, are disposed in a linear series, forming fibres, having generally a longitudinal direction. There is no positive difference to be detected in the structure of the nervous tissue, existing in the brain and spinal marrow, and in the nervous cords emanating from them and distributed throughout the system. The only difference is, that the first is accumulated in masses, and the other is disseminated.

The nervous substance consists of two portions. That which forms the larger portion, is white and soft, called medullary. The nerves appear to be formed entirely of this substance. The other on account of its colour is named the gray or ash substance, and from its disposition in the encephalon, surrounding its exterior, it is named cortical. In the spinal marrow instead of being external, it forms the centre. It is also found dispersed in the

encephalon in masses, but modified in colour, whence it is sometimes called yellow and black substance. The gray substance is much more vascular than the medullary; its colour is in fact owing entirely to its numerous vessels. The globules that compose it are irregularly arranged, and no fibrous appearance is detected in it, as in the white medullary substance.

All of the organs are not in direct relation with the nervous system, and with those organs in which it does exist, this relation is in different degrees. Nerves have not been detected in the cellular or adipose tissues, the serous membranes, the bones, or their medullary membranes, the cartilages, the fibrous parts of the epidermis, and its annexes—the hair and nails, or in the transparent cornea, and the crystalline lens.

Of the organs to which nerves are distributed, those of the chest and lower belly receive the least numerous and the smallest. Of the splanchnic viscera, the stomach and duodenum, are the most liberally furnished with nervous influence, to which circumstance is owing their predominance, in the healthy and morbid conditions of the economy. The vascular system is more freely supplied; the arteries more so than the veins and lymphatics. The muscles are furnished with nerves of a greater volume, though there are considerable differences in respect to different parts of the muscular system. Those of the heart are much smaller than the nerves of muscles subject to the will; and of the voluntary muscles, those of the eye are the most liberally provided with nerves both as to size and number. The nerves of the flexor muscles, are also larger and more numerous than the nerves of the extensors.

The organs of the senses may almost be looked upon as annexments of the nervous system, from the abundancy of nervous substance, distributed to them. The skin, of the sensitive organs, receives the least voluminous nerves, though all parts of it are not alike in this respect. The ends of the fingers, the lips, the penis and the clitoris are richly provided with nerves. The olfactory membrane of the nose, and the gustatory membrane of the tongue, possess a still larger quantity of nervous substance, and the largest nerve of all is the optic.

The most important of the organs, and all those that perform different actions, possessing a compound function, receive different nerves from different sources. The organs of the senses with

the exception of the skin, besides the proper nerve of the sense, receive nerves from another pair, usually the fifth pair; while the muscles of the face, connected with the functions of respiration and the expressions, have branches proceeding from the fifth and seventh nerves. The lungs, the stomach, &c. are united with nervous cords to the cephalo-spinal system, and the great sympathetic.

The nervous system is abundantly supplied with the sanguine fluid. Exact and careful calculations show that an eighth of the whole mass of the blood is sent to the brain, while all the nerves receive in their course numerous vessels of considerable size, when compared to their own bulk.

The nervous system it has been shown, consist of various portions, differing in form, in disposition, and sometimes in physical characters. This question then presents itself. Is it a single system, or does it consist of a plurality of systems? Until a short period the nervous system was regarded from a remote period, as a unit in its functions. It is among the most brilliant and useful of the modern discoveries, and which illustrates the medicine of the nineteenth century, to have demonstrated the nervous structure, to be a plurality of organs. United into one system, they each possess different aptitudes and powers. The offices of some of these organs have been discovered, and though much remains still to be disclosed, we have a right to conclude, the spirit of research that is directed to this interesting subject, at this day, and which, within a short time, has revealed so much that was unknown, will before long, render our knowledge of the apparatus of the nervous organs, and their functions, the most familiar of the facts of our science.

Two principal divisions exist in the nervous system; 1st, the brain, the spinal marrow, and their nerves; and 2d, the great sympathetic or intercostal nerve, spread along the neck, in the chest and abdomen.

§ 1.—*The Brain, the Spinal Marrow, and their Nerves, or Cerebro-Spinal System.*

The first of these divisions, the seat of the sensations, of intelligence, of voluntary movements, and the expressions, places man in relation with the exterior objects around him. It is named the nervous system of animal life, or of the functions of relation.

The second division being appropriated to the organs, destined to the nutrition of the individual, and to the reproduction of the species, is named the nervous system of organic life. The two are not completely independent of each other: they maintain connexions, and mutually influence each other under certain circumstances.

The nervous system of animal life, or of relation, is composed of several distinct apparatus, presenting different phenomena, or exercising different functions. The brain is the instrument or the organ of the intellect, and it is more than probable, that the doctrine of Gall is correct, that assigns a particular organ of the brain to each faculty. The seat of these faculties it is difficult to assign with precision, but it can be affirmed beyond a doubt, that the nobler and higher faculties, are located in the anterior and superior parts of the brain, while the secondary faculties have their residence in the posterior and inferior portions of the encephalic structure.

For sensation and voluntary movements, the performance of respiration, &c. there are also separate nervous organs or apparatus. The principal of these are seated in the medulla oblongata, and the superior portions of the spinal marrow.

The nerves or nervous cords are similar in structure to the medullary matter of the brain, and consist of numerous filaments enclosed within a sero-fibrous tissue, the neurilema, similar to the dura mater of the brain.

The nerves are intermediate between the nervous expansions or tissues in the organs, that are the recipients of external impressions, and the cerebro-spinal organs to which they propagate those impressions. They transmit also to the organs the stimulations and influences that are awakened in the brain, whence result locomotive movements, expressions, or convulsions, in the muscles, as produced by the excitement of the passions, volition, or morbid irritations; all the varieties of painful or pleasurable sensations; invigoration or torpor of capillary circulation, of the secretions, &c. For the conducting of these various excitations different nerves exist. Some for the voluntary movements; some for tactile impressions or the sensations; some for innervation, or the excitation of the organic actions in different tissues, and of functional actions.

The third portion of the nervous system of relation, is the nervous expansions or tissues existing in and entering into the composition of the organs. These exist independently of the brain or nerves. They are formed simultaneously with the organs of which they are a component part; and their formation is not prevented by the absence of the brain. In the acephalous fœtus, the retina, notwithstanding the absence of the brain, is perfect in the eyes. In the other organs of the senses the same fact prevails.

These nervous expansions or tissues are different in every organ. The retina, the olfactory expansion on the Schneiderian membrane, the nervous tissue of the labyrinth, and of the skin and internal mucous membranes, are each dissimilar, and of consequence cannot possess the same identical modes of action and function. The same impression made by the same substance, causes different phenomena in each. A galvanic current applied at the same time to the retina gives a sensation of light, to the tongue a peculiar taste, and to the skin a painful sensation of heat. The prick of a needle in the skin imparts a sensation of pain, in muscle excites contraction of its fibres, in the retina produces impressions of light.

The difference of sensation in these cases must depend on a difference in the structure of the nervous expansion or tissue, that receives the impression, and the consequent difference of sensibility.

In the lower animals, in which no central nervous mass exists, each portion of the nervous system is independent. In the higher order of animals and in man, in which new parts are added, and with each addition new functions exist, the nervous organs and functions, though distinct, become less and less independent. They are subjected to a centre of action, whose integrity is essential to the accomplishment and regularity of their offices. In man, this physiological centre, is the superior portion of the medulla oblongata. To this point are transmitted by the nerves all tactile impressions, and whose transmission to this point constitutes sensation; for if the impression be prevented from reaching this point, as by ligatures on the nerves, or their division, no sensation is perceived. From this point also emanate the movements or stimulations excited and directed by volition and the passions, that when transmitted through the apparatus and nerves

destined to voluntary movements, excite muscular contraction and produce locomotion, the expressions, &c.

Respiration depends also on the integrity of this portion of the nervous structure, and the communication between it and the muscles appropriated to its performance. Hence death, in apoplexy or fevers occasioning effusions at the base of the brain, or by the division of the eighth pair of nerves.

But sensations are not the only impressions that are conveyed to the nervous centre, or volitions the only movements transmitted from it. All impressions, even those of the healthy vital or organic actions and functions, are equally conveyed to the centre of nervous action, and every movement of this centre is reflected into the whole of the nervous apparatus. Of the transmission of the natural or healthy stimulations or impressions resulting from the organic and functional actions of our organs, we are not usually conscious, nor do they produce manifest evidences of their transmission; but in their anormal or morbid state, where the organic actions become exaggerated in any one organ, then they do awaken perception, they create disturbance, they are repeated in the nervous centre, and this excited and disturbed action of the centre of the nervous system, is reflected into the whole system through the medium of the nerves, that emanate from it.

Indigestible food in the stomach and bowels when the mucous tissue is irritated, and worms in the intestines, excite convulsions, especially in children and persons of a nervous temperament. In these instances the irritants are mechanical; the brain can be affected by them in no other manner, than by the increase of the irritation, or of the organic actions of the surface to which they are applied. But convulsions are an effect of irritation in the central nervous structure, appropriated to the excitation of muscular contraction or voluntary movements. The convulsions induced by the causes mentioned, must then be occasioned by the transmission of the irritation awakened in the gastro-intestinal mucous tissue, through the nerves, the only mode of communication, to the brain; and the disturbance of its action is reflected into the muscular and other systems. Splinters and other mechanical irritants lodged in a fascia, &c. and which can produce primarily no other than a local and mechanical irritation, occasion tetanus, which is a general spasm resulting from disorder in

the functions of the central mass of nervous structure governing the muscular system. But this morbid state has succeed to a local irritation at the extremities of the nervous fibrils, or in the nervous expansion of an organ, and consequently must be caused by the transmission of this irritation through the nerves to the central organs.

Apoplexy, hydrocephalus, coma and other affections of the brain, are observed to succeed the administration of irritating drugs, as emetics, purgatives, &c. when the stomach and bowels are in a state of sanguine or inflammatory irritation, and which are occasioned in the same mode as convulsions, by the transmission of the stimulations excited in the gastro-intestinal mucous tissue to the brain. In these instances the transmission is not direct, but through the medium of the ganglionic system.

§ 2.—*The Great Sympathetic, or Intercostal Nerve; or Ganglionic Nervous System.*

Of the second division of the nervous system, the ganglionic, or great sympathetic, our information is exceedingly vague and indefinite. It performs undoubtedly a most important part in the production and support of the functions of the viscera, and of the phenomena of what has been named organic or vegetative life, nutrition, the secretions, &c. But removed as it is from a close inspection, or the reach of experiments, and compelled to rely in a great measure on analogical reasoning, our results in determining its offices must be deficient in the positiveness that is to be desired in scientific investigations. An attention to the anatomical arrangement and various distribution of the ganglionic system, may however enable us to throw some light on its functions.

This system extends along both sides of the spine, penetrates the cranium through the carotid canals, enters the sockets of the eyes, descends through the thorax, traverses the abdomen, and the two lateral portions meet and unite at the coccyx. It thus surrounds and includes within its circuit all the viscera of the thorax and abdomen, to which it largely distributes nervous cords, and is intimately connected with some of the organs of the senses.

This system consists of numerous nervous masses called ganglions, and nervous cords and filaments. The ganglions have no resemblance to any portion of the nervous structure of animal life,

or of relation. They are of a reddish or grayish colour, and soft spongy texture. They abound in fine blood-vessels, which is an indication of an active circulation and a function of importance in the economy. The true offices of the ganglions are not known; in this respect, all is conjecture. Bichat supposes them to be nervous centres, each independent, but connected with the others, and presiding over the nervous acts necessary to organic or vegetative life. No positive facts sustain this doctrine.

The nerves of this system have not a perfect similarity, and possess a different distribution. They may be divided into three classes. The first, which have a strong resemblance to the nerves of the cerebro-spinal nervous system, communicate immediately with that system; they do not anastomose or give off branches, but appear to constitute a connexion between the ganglionic system and the cerebro-spinal system. The second pass from one ganglion to another, in which manner the whole are connected together and communications are established between the different parts of this system. These nerves have also a considerable resemblance, consisting of bundles of filaments enclosed in a membrane, to the nervous cords of animal life. The last class proceed from the ganglions, anastomose with each other, ramify infinitely, forming plexuses, and are distributed to different organs. The nerves of this last class differ from the others. They do not consist of bundles of filaments, but appear to be formed of a soft pulp of a reddish colour and devoid of neurilema.

From these plexuses proceed off nerves destined to the viscera, to arteries, and to muscles. The nerves that pass to the viscera plunge into them along with the arteries they receive. Those that belong to the arteries interlace so closely around them, as to form as it were an exterior nervous coat, and are expended in the arterial tunics.

The muscular branches are in part distributed to muscles that are not influenced by volition, as the heart and the muscular tunics of the alimentary canal; while others are sent to muscles that receive nerves from the cerebro-spinal system and are controled by the will, as the diaphragm and muscles of respiration.

The most important and the largest plexus formed by the anastomoses and ramifications of these nerves, is the solar, arising from the semilunar ganglions. It is situated below the diaphragm,

behind the stomach and duodenum, which are freely supplied by its nervous filaments. This circumstance, it is probable, gives to these organs the pervading influence they are observed to possess in the functions of the economy. This plexus is a connecting point between the two nervous systems, the cerebro-spinal and the ganglionic. The connexion is established by the pneumogastric or par vagum, which emanates from the medulla oblongata and anastomoses with the solar plexus, in which its last ramifications are lost.

Considerations based on the anatomical structure, lead to the following inferences as to the functions of the ganglionic system. *a.* It is not independent of the cerebro-spinal nervous system, but derives its nervous activity from its connexion with that system. *b.* It is connected throughout its whole extent by the numerous nervous filaments passing from one ganglion to another, and uniting together the different plexuses. *c.* The organs of the head, neck, thorax and abdomen, with the genital organs, which receive nervous filaments from this system, are placed in a communion of actions and impressions, which are transmitted from one to the other, and it is thus the principal instrument of the sympathies between those organs. *d.* Supplying the thoracic and abdominal viscera, and genital organs with nerves, and communicating with the cerebro-spinal nervous system, it is the medium of communication between these organs and the nervous system of relation. *e.* Supplying the abdominal and thoracic viscera and genital organs, with numerous nerves, this system must be the chief agent in maintaining the exercise of their functions. *f.* From the quantity of nerves it distributes to the arteries, the closeness with which these vessels are invested with those nervous filaments, and which are lost in their coats, it must exercise an active agency over their circulation, and in this manner influence the secretions and nutrition. *g.* The muscles that receive nervous filaments from this system, have this peculiarity, that they act without volition, or even consciousness. They must consequently receive the nervous stimulation for this purpose from the ganglionic system.

From physiological and pathological facts, we derive a confirmation of these principles and obtain additional light in arriving at a knowledge of the functions of this system. It has been stated,

that the involuntary muscles, the heart and muscular coats of the alimentary canal, receive their nervous supplies from the plexuses of the ganglionic system.

Muscular contraction requires always nervous stimulation for its accomplishment. The action of the involuntary muscles must consequently depend immediately on the ganglionic nerves.

Nervous power is thus provided for these muscles, and at the same time is placed without the domain of volition and the locomotive nervous apparatus.

This is a wise and necessary provision. Had not this independence been established, every attack of convulsions would prove fatal by the spasms that would be induced in the heart. In the moments of ennui, of depression and despair, to which the mind is subject, when suffering under moral afflictions and calamities, self destruction would have been the constant refuge of the wretched against the evils attached to our existence, had the action of the heart been subjected to the control of the will, which could thus suspend its function and occasion instant death.

The diaphragm and muscles of respiration that receive nerves from both systems, are under the control of the will to a certain extent. This provision was necessary for the production of phonation, or the various phenomena of the voice; for the performance of expectoration so necessary to disembarrass the lungs of mucus and foreign matters; to fix those muscles in violent efforts, &c.

But the function of respiration is directly concerned in the maintenance of life, and to the support of the actions of all the organism. Hence it was an indispensable condition that the muscles by which it is performed, should obtain a nervous supply from a source not liable to the accidents connected with the voluntary powers.

The nervous system of relation or animal life has its actions suspended during sleep, and volition partakes of this condition. Respiration nevertheless continues unchanged. In apoplexy, a more profound lesion exists, and all the faculties and actions of the life of relation are aberrant, suspended, or even annihilated, yet respiration is but slightly affected, and continues to preserve existence in the organism for a considerable period. An opportunity is thus given to repair the mischief, which would other-

wise be inevitably fatal. In these states the muscles of respiration can be enabled to execute their offices only through the nervous ganglionic system, from which they derive the requisite nervous energy. It thus appears that a part of the functions of this system, is to place at the command of the viscera and the muscles it supplies with nerves, a stock of nervous power that is independent of volition, and exempted from the numerous sources of derangement that constantly occur in the nervous system of relation or animal life.

The mucous tissues of the bronchiæ, stomach, fauces, rectum, bladder, vesiculæ seminales, and the testicles, are the seats of the sensations that constitute the instinct of want of respiration, of hunger, of thirst, of defecation, of urination and sexual intercourse. These sensations depend on the ganglionic nerves of the tissues which are their seats. But the gratification of these instincts depend on acts that are entirely under the control of volition, and which cannot be provoked directly by the ganglionic system. These instincts the will may for a time neglect to obey; and refuse to lend itself to the call of these sensations. But in a shorter or longer period, it must yield to their solicitations, and command the actions by which they are to be appeased. These instinctive or internal sensations, do not possess an equal power in compelling the acts of volition. Those attached to functions of the most immediate necessity, are the most imperative in this respect.

The want of respiration is that which can be resisted the shortest time. This sentiment becomes so overwhelming, the stoutest resolution quails before it and yields to its demand. No one has ever been able to suspend voluntarily his respiration so as to produce asphyxia. Hunger and thirst may be resisted and their gratification postponed to answer the means or the convenience of the individual, but when the system begins to suffer from the wants of nutrition or of fluids, these sentiments become irresistible, and it is no longer possible to restrain the voluntary acts necessary to allay them. Hence the proverb, *hunger will break through stone walls.* The same observations are applicable to defecation and urination, which may be delayed for appropriate occasions.

The want of sexual intercourse not being essential to the

maintenance or preservation of the individual, but intended for the continuance of the species, is less urgent in its necessity, and is also in its demand. It is consequently placed more effectually under the control of the will, which may resist its solicitations, and yield a compliance only in comformity to the regulations of moral discipline.

The ganglionic system furnishing the principal nervous supply to the surfaces, where are seated the instinctive wants of the organism, we have in the above facts the evidence; 1st, that the ganglionic system is the nervous apparatus of the instincts and internal senses; 2d, that it communicates to the nervous system of animal life, or relation, the wants of the economy; and 3d, is capable of compelling that system to command the acts necessary to supply those wants.

The interrogation of pathological phenomena will furnish additional elucidation to this subject.

Irritations excited in the mucous tissue of the stomach and small intestines, by the impressions of irritating agents, will excite irritations in the brain, and sometimes spinal marrow. The acute inflammations of the gastro-intestinal mucous tissue rarely, it may be asserted, never fail to occasion cerebral or spinal inflammation. Hence they are invariably attended with head-ache and delirium, pains in the back, and often neuralgic pains in the extremities; they frequently occasion coma, apoplexy, hydrocephalus, convulsions and paralysis. The chronic inflammations of the same tissue, are also productive of chronic inflammations of the cerebral organs, and hence we find mania, monomania, catalepsy, epilepsy and hysteria, are frequently connected with that state of the digestive organs. The connexion between the cerebro-spinal organs, and the mucous tissue of the stomach and small intestines, by which the actions of the one are transmitted to the other, is most probably effected through the nerves of the ganglionic system, and the inosculation of the solar plexus with the par vagum.

None of the viscera that are placed under the influence of the ganglionic system of nerves, exercise so decisive and prominent an action over the cerebro-spinal nervous organs, as the stomach and small intestines, especially the stomach. This circumstance as was previously observed, is in correspondence with the larger

supply of ganglionic nerves it receives, and its more intimate association with the cerebral organs through the solar plexus and par vagum.

The irritations and morbid condition of the stomach, exercise an active influence over all the organs embraced under the dominion of the ganglionic system, and the morbid condition of any of those viscera are reflected on the stomach. There is thus established a reciprocal sympathetic influence between the vicera of organic life, or those over which preside the ganglionic system of nerves.

The heart more than any other experiences this agency of the stomach. The irritations of the mucous tissue of the stomach, with few exceptions, are extended to the heart; its action becomes quickened and febrile symptoms are induced. The same result may occur from the irritations of any of the other viscera, but it is less constant with them than with the stomach; and in reality, it will most generally be observed, that when fever attends on the inflammations of other organs, the stomach has partaken of the morbid irritation. The general occurrence of these facts, at one time, induced M. Broussais, to entertain the opinion and inculcate the doctrine, that irritation of the gastro-intestinal mucous tissue, was a necessary prelude to the establishment of fever, without which it was never manifested. This absolute generalization of facts, perfectly excusable from the frequency with which they are observed, was too hastily made, and in the manly and frank spirit of a true philosopher, has been amended upon mature observation and reflection.

With less promptness and less constancy, the other organs in this connexion, respond to the morbid irritation of the gastric mucous surface. An example is afforded in acute gastritis, in which the eye is always injected with blood, the fauces and tongue are arid and inflamed, the lungs often partake of the disorder, and respiration is impaired or deranged. The liver, the kidneys, the genital organs, all display more or less of disturbance, in their functions corresponding to the degree of the gastric disease. The acute irritations of those organs are attended, in a like mode, with disorder and disturbance of the stomach and its functions. Thus inflammations of the kidneys, uterus, liver, and sometimes of the eye, are

productive of an irritable state of the stomach, exciting nausea and vomiting.

The above pathological phenomena exhibit; first, a close connexion between the stomach and the brain, by which they mutually reflect their irritations on each other; and second, that the different organs to which the ganglionic system sends nerves, possess a free communion in their actions, which is most extensive and active between those organs most abundantly supplied with nerves. The ganglionic system, from these facts, would appear to be the medium of the sympathies, that bind together the viscera of the splanchnic cavities—the cranium, thorax, abdomen, and the genital organs.

From the preceding anatomical, physiological and pathological considerations, the functions depending on the ganglionic system, may be embraced under the following heads.

a. It is not independent of the nervous system of relation. It does not collect to a fixed centre, like the encephalon, nervous impressions or stimulations of which it takes cognizance similar to the central organ, the brain and medulla oblongata, and from which originate other stimulations exciting especial actions.

b. This system is generally connected throughout its extent, from the cranium to the pelvis.

c. It is connected with the cerebro-nervous system, from which it derives, and to which it transmits its nervous stimulations. Its principal medium of connexion with the brain, is by the par vagum and solar plexus.

d. It is the principal and most active agent in conveying nervous stimulations or power, which it derives from the cerebro-spinal system, to the viscera of the abdomen, thorax, and genital organs.

e. It influences the circulation of the vessels of those cavities, and in this manner has an effective agency in the secretions and nutritions.

f. It places at the disposal of the abdominal and thoracic viscera, and involuntary muscles, nervous power for the support of their functional acts, necessary to the maintenance and preservation of the individual, and which is thus abstracted from the immediate control of volition, and defended from the numerous

and sudden derangements to which the cerebro-spinal nervous system is liable, from moral and physical causes.

g. It is the nervous apparatus of the instincts or internal senses, and by the nervous filaments it distributes to the internal mucous membranes, makes them the seat of the internal senses.

The instincts or internal senses are modes of being analogous to irritations, of the internal mucous membranes, which excite nervous stimulations in the ganglionic nerves. Thus common irritation at the termination of the rectum, imparts an incessant sense of want of defecation; at the neck of the bladder, of want of urination; in the vesiculæ seminales and testes, of want of coition; in the stomach, as is seen in chronic and the subsidence of acute inflammations, and in some fatal cases of fever previous to death, a sentiment of hunger, which the patient cannot resist or control.

h. It communicates to the cerebro-spinal system, the stimulations that constitute the instincts or internal sensations, and thus brings under its cognizance, and makes known to the intelligence, the wants of the viscera, and the organism.

j. It can, when necessary, force the attention, or consciousness, and volition to the wants of the viscera and economy, and can compel them to command the voluntary movements requisite to supply those wants, or to procure their gratification.

k. It conveys morbid irritation of the mucous tissue of the stomach, to the apparatus of the voluntary movements, and excites them into action, without the concurrence of the will, and even in opposition to its dictates. Hence convulsions, spasms, &c.; hence also, the violent struggles of those whose stomachs are excessively irritated by ardent spirits, indigestible food, and other causes; and which they find it impossible to resist. In a similar mode, the moral or affective faculties, are irritated and excited by irritations of the mucous membrane of the stomach. This is a productive cause of numerous crimes, especially from the abuse of ardent liquors. The slightest opposition or contrariety, occasions, then, the fiercest explosions of temper, and leads to the perpetration of acts, at which the individual, when sobered, shudders with horror. The same effect occurs from the irritation of hunger, and in those of irritable stomachs, during the act of digestion.

l. The ganglionic system is intermediate, or is the organ or

medium of communication between the brain and spinal marrow, and the viscera of the thorax, abdomen, and the genital organs; or between the organs of relation or animal life, and the viscera of organic or vegetative life.

m. It is the organ of the sympathies, healthy and pathological, between the different organs of organic life, (the thoracic, abdominal and genital,) and between them, and the brain and spinal marrow, or the organs of relation.

In this manner, the nervous system in its totality, is intermediate to all the organs. It connects them by ties so intimately, that the changes which supervene in one organ, is perceived, not only in the central mass, but determines through it, modifications in the actions or states of other organs. This transmission of actions from one organ to another, having no immediate functional dependence, or structural relation, constitutes sympathy, of which the nervous system is the organ or instrument.

The nervous tissue, from its vascularity, is subject to sanguine irritation and inflammation, similar to the other tissues, and which is attended with the usual results of disorder and disturbance of function, and disorganization of its structure.

The consequences of inflammation in nervous tissue, will offer the most diversified results, and be productive of the most varied phenomena, according to the offices of the part in which it may be located, and the degree of its intensity. In the hemispheres of the encephalon, it will give origin to the numerous forms of mental alienation, maniacal delirium, monomania, melancholia, dementia; in the central masses regulating the movements, to convulsions, to chorea, to spasms, to paralysis; in the apparatus of sensibility, to the different shades and states of the sensations, burning, itching and lancinating pains—neuralgia; or to a total loss of feeling.

The nervous system being a complicated structure, whose numerous organs are perfectly distinct, and whose functions are entirely different, any one may be separately affected without necessarily involving the others.

The intellectual and affective faculties, are each distinctly subject to be highly disordered without sensibility, or locomotility, or innervation being disturbed. The locomotive faculties may be seriously implicated, while the intellectual and moral, are in

the most perfect integrity. The same is observed of sensation.

In the same apparatus of organs, a part only may be deranged, while the remainder executes its functions in a perfect manner. Partial paralysis and spasms, afford examples in the apparatus of locomotion. Neuralgic pains affecting certain nerves, present instances to the same purpose, in the apparatus of sensation. Monomania, or derangement on one train of ideas, the mind perfectly sane, and even vigorous on all others, is an exhibition of the same occurrence in the intellectual organs.

Each part of the nervous system appears to produce its own sum of nervous principle or power. It is not a common stock diffused and transmitted throughout the whole. For example, the nervous cord or nerve, the nervous expansion or membrane in an organ, and the central organ in the brain, each produces in its substance its own stock of nervous principle or neurosity, as it may be termed. To occasion the particular phenomena of a nervous function, as of sensibility, or locomotion, or of the senses, for instance, the connexion between all the parts of the apparatus appropriated to that function must exist, and each be in a natural state.

The impulse or stimulation that elicits the particular nervous phenomenon, as light impinging on the retina, which occasions vision; the vibrations of the air, transmitted to the nervous membrane of the labyrinth, whence is caused hearing; tactile impressions on the skin, producing sensation; volition directed on the organs of voluntary motion, that gives rise to voluntary movements, &c., is, then, extended through the whole series of the apparatus, and the function is complete, the phenomena are perfect.

A defect or interruption in any one part of an apparatus, is attended with defect or suspension of the function and phenomena, depending on that apparatus, corresponding to the degree and extent of the lesion. From these causes proceed the local and limited nature of most of the affections of the nervous system.

The nervous principle, the immediate agent of the nervous phenomena, is constantly fluctuating. It is exhausted by its activity, and requires a constant recuperation. Hence all nervous phenomena are intermittent, or have periods of repose and of action.

The production of this principle, and the persistence of the nervous functions, are immediately concatenated with the free and healthy circulation of oxygenated or arterial blood. The moment unoxygenated or venous blood passes into any portion of the nervous system, or its circulation is interrupted, the functions and actions of that part cease. A ligature placed on an artery supplying a limb, destroys the sensibility and capacity of motion in that limb, until the circulation is restored. If the function of the nervous organ be immediately essential to vital phenomena, the presence of black or unoxygenated blood proves fatal. This is the cause of death from asphyxia, occasioned by black blood passing to the brain and medulla oblongata, which annihilates the functions of the respiratory nerves, and prevents the restoration of that vital function.

The nervous principle is thus immediately dependent on the state of the circulation in the nervous structure, and when this deviates from its natural or healthy condition, in any portion of the nervous system, there is a proportionate morbid change in the functions of that portion. Most of the morbid conditions of the nervous system have their origin from this cause.

Sanguine irritation and inflammation of nervous substance, assume both the acute and chronic shape. The acute is the most clearly marked and the best known. The symptoms created by them have been classed by nosologists under the head of Neuroses, and seldom have they been regarded as connected with the vascular derangement of the nervous structure.

Inflammation of nervous substance is productive of various alterations of structure. The medullary portion acquires a slight reddish or pink tint, while the cortical becomes dark; it offers, when sections are made, numerous red points from the divided capillaries that have been injected with blood; it is firmer, more compact and drier than is natural. A higher degree of action occasions suppuration, which is often local and collected into abscesses. But it frequently is more diffused and produces extensive softening of the nervous substance, which in its highest degree is analogous to gangrene.

The vessels that convey blood to the nervous structure, surround its exterior, and are enveloped in a cellular tissue, the pia mater, which is covered in the brain by a serous tissue—the arach-

noid membrane. Sanguine irritation and inflammation in the nervous substance, producing towards it an increased afflux of blood, the net-work of vessels on its exterior are necessarily congested with blood, and the membranes surrounding it, always partake of its inflammation. The pia mater, in the inflammation of the brain, is uniformly loaded with blood in the part covering the inflamed portion, and presents different phenomena, the result of its own irritation and inflammation, as effusion of serum, of a gelatinform fluid, of coagulable lymph, &c. The arachnoid is frequently affected, also, consecutively to the inflammation of the brain, when serous fluid is effused between its surfaces, it is rendered opaque, thickened, &c. Most generally, however, the arachnoid secretion is not augmented in the inflammation of the cerebral structure; the effusion being found in the web of the pia mater, beneath the arachnoides, and not within its sack, as it is mostly supposed to be.

The nervous power or material, is directly influenced by its peculiar modifiers, and these acting in excess may occasion morbid or anormal phenomena, independent of sanguine irritation, or inflammation, in nervous substance. This constitutes *nervous irritation*.

Persons, especially females, of a highly nervous temperament, with great activity of the nervous system, will often be thrown into hysteric convulsions by a sudden moral impression, or an unexpected occurrence, as a loud noise; and mechanical irritation of a nerve, or the posterior columns of the spinal marrow, will cause convulsions in the muscles. In these instances the disturbance is provoked in the nervous principle or agent, or the neurosity independent of vascular action.

Sanguine irritation and inflammation of a highly acute character in a tissue, attended with acute pain, in those of a nervous temperament, by the local nervous excitement they occasion, often cause convulsive, spasmodic, or other nervous phenomena. In such cases, the nervous disturbance is wholly independent of sanguine irritation in the nervous substance itself. It is a complication accompanying, and often masking the more important inflammatory action that has been merely the exciter of the nervous symptoms.

Purely nervous irritation is a consequence of excessive stimula-

tion, or impression on the nervous matter, by those causes or agents, which in the order of nature, are capable of modifying its condition. Nervous irritation is in this respect analogous to sanguine irritation: it is caused by excess in the natural or healthy action or movements of the nervous substance, as sanguine irritation consists in excessive or exalted action of vascular tissue.

A principle of importance from its practical bearing is established by these facts; viz. that nervous symptoms or disorder of nervous functions, will arise from two causes: 1st, sanguine irritation, or inflammation in the nervous structure or substance; and 2d, simple nervous irritation produced by the excessive impression of the modifiers of nervous energy, or its too great activity.

Sanguine irritation or inflammation in tissues rich in nervous structure, and having an intimate connexion with the nervous system, is often an exciter of nervous irritation, and nervous irritation, when highly aggravated and intense, becomes also an exciter of sanguine irritation.

Sect. IX.—*The Tegumentary, or Cutaneous System.*

The tegumentary, or cutaneous system, is spread over all the surfaces that have directly or mediately exterior communications. Hence it covers the entire surface of the body, and penetrating the interior, it lines the cavities having an external opening, such as the mouth, the œsophagus, the stomach, the intestines, all the excretory ducts that terminate in these portions—salivary, hepatic, and pancreatic. It lines also the ærial passages, the nasal fossæ and their sinuses; the genital, urinary organs, &c.

This system is divided into two secondary systems, the external tegumentary or cutaneous, designated as the skin, (cutis,) or common integument, and the internal tegumentary, or the system of the mucous membranes. There are considerable differences in some respects between these two sections, yet they are only modifications of the same structure. They are continuous, the one passing into the other; they have the same form, same structure, and nearly similar functions. The most considerable portion of the system of the tegumentary membranes, is the skin and the mucous membranes succeeding to it, which last forms a tube, extending from the head and through the trunk,

named the alimentary canal, commencing at the mouth and terminating at the anus. Besides this last mucous membrane, there exist others of less extent, which penetrate into the intermediate substance between the two sections, and represent ramified cul-de-sacs—as the internal membrane of the meatus auditorious externus; that which lines the internal face of the palpebræ or eyelids and the anterior face of the eye and lachrymal passages—that which penetrates the mammary glands through their excretory ducts; and the lining membrane of the genital and urinary organs.

The internal tegumentary or mucous membrane has numerous appendances or prolongations. In the cavities of the mouth and nose, it extends into the salivary and buccal glands; in the pharynx it divides and sends a large branch into the trachea arteria, which ramifies in the bronchial tubes in the form of culs-de-sacs, forming the interior membrane of the respiratory organs. Another branch is sent through the Eustachian tube into the internal ear. Below the diaphragm it forms new cul-de-sacs, sending prolongations into the interior of the liver and pancreas through their excretory ducts.

Mucous membrane forming the internal cavity of all secreting glands, and constituting so considerable a portion of their structure, has led some physiologists to regard the glands as appendages to the mucous membranes.

The tegumentary system every where presents two surfaces. The one adherent, the other free. In the mucous membrane the adherent surface is external, and the free, internal; in the skin this arrangement is reversed. The free surface of the tegumentary system, especially the internal or mucous membranes, is disposed in folds, projections and depressions, in different manners and of different nature, that increase its extent. This surface is in a constant relation, either continued or occasional, with substances wholly foreign to the organization. The adherent surface is connected to the subjacent parts by a layer of cellular tissue, that has received in some organs the improper name of nervous coat.

The tegumentary membrane is a compound structure composed of several layers, which are the derma, the vascular reticulated texture, the papillary tissue, the mucous layer or body of Malpighi, and the epidermis. In the tegumentary membrane are

observed in addition to the layers of which its body or mass is composed, numerous simple glands or secretory organs, known under the names of follicles and cryptæ. They appear to result from a simple depression of the tegumentary membranes.

The tegumentary system enjoys sensibility and irritability in the highest degree. In these respects it surpasses the other tissues of the organism. These properties, however, vary considerably in different portions.

This system envelopes all the organs, surrounds the mass of the body, and consequently is exposed to all the impressions of exterior agents. It is placed on the outer boundary of the organism, and receives the first aggression of substances that are foreign and injurious to the economy. It is through the medium of this tissue, the relations of the organism with the exterior world are maintained. It constantly absorbs and introduces external matter into the economy from without; and expels matters not adapted to its wants from within. It is the limit and means of communication between the individual and the rest of nature. This system is the most important portion of all the organs of vegetative life or of nutrition.

The tegumentary system is the organ of general sensation, and of many special sensations; of the absorptions and exhalations. The different portions do not all partake equally of these functions, a difference arising from modifications in its structure.

From the nature of the functions of the tegumentary membrane, and the activity of its vital properties, it is more exposed to morbid impressions, and to disturbances in its mode of action or being, than any other of the organs. Hence the frequency of its deviations from a natural state; and the importance it assumes in all pathological conditions of the economy. It is connected by the closest ties of sympathy with all the important organs, and it exercises the most extensive, it may almost be said unlimited influence, over the general health; and very speedily partakes itself in all the changes that supervene in other organs. The life, the condition of the vital or organic actions of every organ, may be regarded as immediately depending on the life, the state of the vital or organic actions of the tegumentary system.

From these observations on the general tegumentary system, we pass to a general consideration of the peculiarities important

to be known as illustrating its physiological functions, the pathological states and therapeutic relations of its principal divisions.

§ 1.—*External Tegument, or Skin.*

The skin or cutis is that portion of the tegumentary system, that forms the envelope of the entire external surface of the body. Being the limit of the body, the form of this is exactly represented by the skin. It is apparently pierced with openings at several points, as the mouth, the nostrils, the genital organs, the anus, &c. No interruption in the continuity of structure does however occur. At those points, the external tegument or skin, folds on itself, as it were, or is reflected, and passes into the interior, where it forms the mucous membranes.

The skin differs from the mucous membranes, in being more dense, more solid, drier, and possessing fewer vessels.

The skin is the seat of tactile, or passive involuntary sensations; and of touch, or active voluntary sensations. It exhales also two kinds of fluids, the sebaceous, and a fluid of great tenuity, which commonly passes off in the form of vapour, (insensible perspiration,) or, when augmented, in the liquid fluid state, (sweat.) The amount of this exhalation is very considerable, but which differs according to the circumstances in which the individual is placed. The regularity of this function is of great importance to the animal economy, and if interrupted, is always attended with more or less of disorder in the function of some other organs, or portions of the tegumentary membranes.

The skin certainly cannot be regarded as an active or important organ of absorption. The removal of the epidermis facilitates this process, and this mode of influencing the actions of the system, constitutes the endermic medication.

The skin is endowed not only with sensibility, but is in the highest degree irritable. It presents itself to the medical practitioner in an interesting light, considered in its pathological, therapeutic or hygienic relations.

The structure of the skin, as has been shown, being complicated, each of its component tissues may be separately the subject of disease and alterations of structure. This is one great cause of the variety in the appearances or characters of cutaneous diseases.

The external tegument from its extreme irritability is the frequent subject of irritation and of inflammation, which assume different forms, and receive different names, according to the different layers and component elements of the skin that are their seat; according to the intensity of the morbid state, and the nature of the product that is secreted. The positive nature is the same in all, notwithstanding the variety of aspects these affections exhibit. The diseases of the skin, studied, as they have heretofore been, in their external characters, in their forms and causes, which are often merely conjectural, and not from the anatomical structure in which located, and the physiological changes induced, have been little understood; the utmost confusion has prevailed in their classification, and their treatment has been almost entirely empirical.

The inflammations that present the erythemoid character, as erysipelas, the red patches of scarlatina, that which results from slight burns, from the action of rubefacients, vesicatories, frictions, &c., consist in the sanguine injection of the vascular reticulated tissues, but when intense, involves all the different tunics of the skin.

In the slighter degrees of this inflammation, there is merely redness of the surface, with some heat and itching, which soon disappear, and the cuticle is detached in furfuraceous scales. The reticulated vascular tissue is the sole and chief seat of the disease. Should the patient die from other accidents, no trace remains after death.

A more intense degree of the inflammation extends to the derma, the tumefaction is then greater, the part is renitent, and an exhalation more or less considerable, according as the inflammatory action is greater or less intense, of a serous or yellowish fluid takes place, forming minute vesicles—phlyctenæ or ampullæ. When these are broken, and the inflammatory action is maintained, a purulent secretion is established.

A more active degree of the inflammation will often be extended through the skin, into the cellular tissue beneath, which becomes œdematous, or the seat of a purulent secretion, according to the degree and extent in which it is effected, and is termed phlegmonous erysipelas.

Inflammation of the skin, when excessive, often terminates in

gangrene. It is subject also to limited hæmorrhages, forming petechiæ in malignant forms of fever.

Besides the diffused inflammation just noticed, whose principal feature is derived from the vascular reticulated tissue, the skin is subject to special local acute inflammations, whose prominent character is the development of pustules. Such are the small-pox, varioloid, vaccine and measles. The tunic or layer of the skin, the seat of these affections, is not clearly ascertained. It is usually supposed to be the derma, in variola and vaccine. The question is not definitely settled, but I am more disposed to regard the external vascular tissue, as the portion of the skin in which the exanthemata are placed. It is certain that when the disease is severe, the derma suffers from ulceration. The exanthematæ produce pustules of a rounded form, and are the results of a local exaltation of the organic action of the cutaneous tissue, which, from a central point extends to a limited distance, presents the characters of inflammation, and produces the formation of a particular fluid.

The exanthematæ are, however, more properly small abscesses, that occur in greater or less number. Those of small-pox and vaccine are of a rounded form, flattened, with a central depression, and an interior areolar disposition. The depression is caused by the adherence of the cuticle in the central point, by means of small filaments to the subjacent tissue, while the secretion of the pustular fluid elevates the surrounding cuticle. The pustule is thus formed by a partial separation of the cuticle, caused by the fluid secreted beneath it. When the pustules are few in number, they are always distinct, but when numerous, the pustular fluid is secreted on so many points, the cuticle is separated too extensively to confine it in a limited sphere. In the first case we have discrete small-pox, in the last confluent small-pox.

The skin is subject in its various tissues, to chronic inflammations, forming the numerous chronic, eruptive and exanthematous affections, as herpes, tænia, &c. Some of these commence in the superficial layers, others in the sebaceous and mucous follicles. Notwithstanding the great variety of forms assumed in the exanthematæ, they are all the result of inflammation located in some of the component elements of the skin, and are most successfully treated by the antiphlogistic means directly applied.

§ 2.—*Internal Tegumentary System, or of the Mucous Membranes.*

The mucous membranes consist of all those portions of the tegumentary membranes, which succeeding to, or continuous with the skin, plunge into the interior of the body, and line all the cavities having exterior openings. This system is narrower and more contracted than the external, but it is more extensive, longer, and more diffused throughout the organism. It receives its name from the follicles that are a part of their structure, and that secrete on the surface of these membranes a viscous transparent fluid. This fluid is called animal mucus, and is found only on the surface of mucous membranes.

The internal tegumentary tissues consist of two independent, unconnected portions, each having a separate external opening. The one is the mucous membrane lining the alimentary canal from the mouth to the anus, the ærial nasal passages, &c.: the other comprehends the genito-urinary mucous membrane lining the genito-urinary organs. The first in its course sends off many prolongations into different conduits, excretory canals, glands, &c. as has been mentioned.

The internal or free face of the internal tegument or mucous membranes, is not like that of the skin smooth and even. It presents many inequalities that are greater in some parts than others. The most considerable of these are folds, which sometimes form complete valves; the velum pendulum and ileo-cœcal valve are examples. Others less considerable, exist in the small intestines, where they are known as the valvulæ conniventes.

Besides these inequalities, there are others formed by small projections called papilli and villi; and others made by small depressions, constituting mucous follicles.

The papilli are conical eminences, remarkable on the tongue, &c.: the villi belong to the gastro-intestinal mucous membrane; they are especially to be seen in the stomach, duodenum and jejunum.

Considerable difference exists in the structure of the internal and external tegumentary membrane. The first does not exhibit in every portion all the layers to be found in the external.

Besides the chorion or derma, which is the principal layer, the mucous membranes contain in their structure, follicles or cryptæ, papillæ and villi.

The mucous cryptæ or follicles have the appearance of small cysts, or blisters, or miliary granulations of a grayish-white colour, having narrow necks, opening on the free surfaoe of the mucous membranes by small infundibuliform orifices. They are in some parts of this tissue simple and discrete; in other parts agglomerated in laminæ. The tonsils, the prostrate gland, the glands of Cowper, the carunculæ lachrymales, are only follicles aggregated together. In the stomach they are smaller than in the rest of the alimentary canal. Between the pylorus and ductus choledochus, they are numerous and projecting. At the end of the ileum, the agglomerated laminæ of the cryptæ become more extended, and the cryptæ themselves much larger. In the colon they are more disseminated.

The papillæ are small eminences, vascular, nervous and erectile, scattered over the surface of the mucous membranes. In the organs of taste, they are fungiform or conical, and pediculated. It is said that when examined with a glass, they appear to be composed of small crooked vessels, united by a mucous pulp. They possess an acute and lively sensibility, proving them to be well supplied with nerves, which in some parts are to be discovered by dissection. The papillæ commonly surround the small excretory ducts of the cryptæ, that are disposed in their interstices. They are more numerous and larger in the lingual mucous membrane, than any other portion of this tissue.

The villi are met with only in the gastro-intestinal mucous membrane. By some anatomists it is considered as different from the mucous membranes, and is called the villous membrane. The difference is not however important. The villi are small foliated eminences, that exist in great numbers upon the internal membrane of the small intestines.

When the intestines of a living animal are examined with a glass, numerous small drops of a transparent fluid, totally different from the viscous mucus filling their intervals, is observed oozing from the extremities of the villi, which are straitened and erect. They are thus demonstrated to be the seat of the serous exhalation, which is so copiously discharged by the action

of some purgatives and in diarrhœas. The villosities of the gastro-intestinal mucous membranes, are organs of absortion as well as exhalation, and are in structure small capillary fasciculi enveloped in a fold of the cellulo-vascular pellicle, that lines the interior of the intestinal canal.

The mucous membranes derive their nerves from the nervous system of relation—the cerebro-spinal, and the organic nervous, or ganglionic system. These nerves are not distributed equally to all portions of them. The bronchial, œsophagian and gastric mucous membranes, are those that principally receive cerebro-spinal nerves. That of the small and large intestines are furnished with but a small number, if any, of the nerves of relation.

The coloration of the mucous membranes varies in different parts, and depends on its vascularity. The conjunctiva on the globe of the eye, is colourless and diaphanous; lining the palpebræ it is reddish. This is the hue it generally possesses in the vicinity of the skin, as on the lips, tongue, fauces, &c. In the tracheo-bronchial mucous membrane, the hue is roseate in the larynx, and nearly white as it descends into the tracheæ and bronchiæ. The hepato-cystic membrane is also white. The vulva presents it of a lake colour, which disappears in the vagina, where it is grayish-white. The villous membrane of the stomach and intestines in infants is transparent, and of a white, tinged with rose. In adult life it is a pearl white, preserving still a faint rose; towards the middle of life, it is a dull white with frequently a slightly grayish hue; which, in advanced age, deepens almost to an ash. But this last colour is most probably caused by chronic inflammation.

The mucous membranes possess irritability and susceptibility to the impressions of stimuli in an elevated degree. Their sensibility differs very considerably: except in a few points, in the vicinity of the external teguments, as the lips, mouth, nostrils, glans penis, &c. in which sensibility is very exquisite, this property is obscure. It is doubtful whether, in the natural state, the small and large intestines are endowed with proper tactile sensibility.

The functions of the mucous membranes are various. They are the organs of absorption, and of a serous and mucous secretion. The first proceeds from the papillæ and villi, and the last from

the mucous follicles or cryptæ. The mucous secretion is not the same in every part of the internal tegument; animal mucus, however, always forms its base.

The mucous membranes are, besides their special nervous connexions, the seats of the internal senses, and give rise to the wants of the individual. Thus the gastric mucous membrane is the structure in which the sensation of hunger is experienced; the pharyngeal mucous membrane is that where thirst is perceived; the bronchial mucous membrane experiences the sentiment of suffocation, by which it gives warning of a deficiency of air, or its improper quality, &c. They are also the seat of some of the most important of the vital functions, as digestion in the gastric mucous membranes; respiration in the bronchial; and glandular secretions, probably, in the prolongations into the different glands.

The structure, the functions, the organic and nervous connexions, elevate the internal tegumentary system, or mucous membranes, to the highest rank in the organic tissues. The due and natural performance of its important functions, are absolutely requisite for the preservation of health. It bears the most intimate relations with the external tegumentary system; with the circulation and its central organ, the heart; with the nervous system, &c., and influences them in the most marked manner, both in a physiological and pathological state.

From the view we have taken of the internal mucous tissues or integuments, it will not appear surprising they should command so much attention in modern pathology, in which they are made to perform so important a part. As a surface of relation, they are incessantly exposed to the aggressions of exterior substances; as the seat of the wants, they are liable to be affected by accidents, which prevent their gratification, or by imprudences and errors in their indulgence; as the organ of different important functions, and holding intimate organic functional and sympathetic connexions with the other organs and tissues, they are subjected to have their actions deranged by whatever disturbances exist in the actions of other portions of the organism. The anormal or pathological conditions of the tegumentary system, and especially of the internal or mucous membranes, compose two-thirds of the catalogue of diseases, and they are more or less concerned in nearly the remaining third.

The most common of the morbid conditions or anormal state of the mucous membranes, is the exaltation of their organic actions or nutritive faculty; or in other words, irritation and inflammation.

The inflammation of these membranes is accompanied with different appearances and structural derangement, which has led to a division into different kinds or species of inflammation. The difference is, however, only apparent. They are essentially the same. This apparent difference arises 1st, from the intensity of the inflammation; 2d, the elements or component parts of the membrane that are its seat; and 3d, the quality of the sanguine or nutritive fluid.

The most common form assumed by the inflammation of the mucous membranes, is that which may be termed erythemoid.

The first character of acute erythemoid inflammation is a redness, varying from a rose to a blackish brown; it also is manifested by superficial, lightly injected capillaries, which augment to uniform laminæ of the deepest hue, and occupying the whole thickness of the membrane. In the mucous membranes properly called, the redness is seldom defined by positive limits, but diminishes gradually from the centre of the inflammation. In the villous coat of the stomach and intestines, on the contrary, it is abrupt in its termination.

Mucous membranes, when inflamed, become rugose on their surface, especially those having papillæ, which are rendered erect and turgid. Deep fissures are often occasioned by their enlargement and elevation. This state ceases with life.

The mucous membranes thicken when inflamed and are turgid, from the engorgement of the sanguine capillaries. The degree of the tumefaction depends on the quantity of capillary vessels, and of cryptæ or follicles the membrane contains.

The erythemoid inflammation is seated in the papillæ and villi of the mucous tissue, and in its slighter shades, is confined entirely to their vessels. When more intense, the follicles or cryptæ partake of the inflammatory action. The follicles then enlarge, they lose their density, and they have a slight semi-transparency, apparently from a contained grayish or reddish fluid. Their secretion in the commencement of the phlegmasia is increased; it is less viscid than natural: but when the inflammation advances rapidly, its quantity diminishes and loses its limpidity, while it

becomes more viscous. In the highest degree of inflammation, the secretion is almost wholly suspended; but as the phlegmasia subsides, it is soon re-established, and is then generally mixed with blood, or is of a greenish hue. This augmentation and vitiation of the mucous secretion often persists after the inflammatory actions have nearly ceased.

Inflammation of the mucous membranes suspends or destroys the functions of which they are the organs. Absorption, for instance, no longer takes place when a mucous surface is inflamed. Digestion is impaired or entirely abolished when the gastro-intestinal villous coat is inflamed; and respiration is affected in the inflammation of the bronchial mucous membrane.

The inflammations of different portions of the mucous membranes, present different characters depending on their functions and difference of structure. The fundamental or essential character is, notwithstanding, the same in all; the modification depends chiefly on the nature and elements of the structure in which the inflammation prevails.

Inflammation of the mucous membrane is attended, in some instances, with an œdematous state of the tissue. It has been called œdematous inflammation: there is, however, nothing specific in it to warrant a peculiar title. It mostly occurs in cachectic subjects, or those exhausted by long diseases, and the intemperate. I have seen it occur in healthy individuals, but of feeble constitution, especially women and children. It is always the result of sanguine irritation and inflammation. The œdematous state, or serous effusion into the mucous tissue, is an accident that is connected with the condition of the sanguine or nutritive humour: it is deficient in cruor or fibrin, while the serous or watery portion is predominant and excessive. The congestion that accompanies irritation is, then, chiefly serous, and the watery portion is readily effused.

The acute erythemoid inflammation of the mucous membranes, receives different denominations according to its location. In the conjunctiva it is named ophthalmia; in the lining membrane of the internal ear, it is otitis; inflammation of the nasal fossæ, is coryza; of the mouth, stomatitis; of the tongue, glossitis; in the larynx it constitutes laryngitis, and when accompanied with œde-

ma, the œdematous angina. This last affection is one of extreme danger, and mostly proves fatal from the obstruction and stuffing up of the glottis which it commonly produces. The inflammation of the bronchial mucous membrane, forms bronchitis; that of the hepato-cystic mucous tissue gives rise to jaundice, to the yellow tinge in bilious fevers, and to hepatitis. The membrane that lines the urethra and bladder in a state of phlegmasia of erythemoid character, constitutes urethritis and cystitis. In the alimentary canal, we have gastritis, duodenitis, enteritis, colitis, as the stomach, duodenum, small intestines, or colon are the seat of inflammation.

The inflammation of the gastro-intestinal mucous membrane, has acquired great importance in the pathology of the present day. To this lesion is attributed, by a very large portion of the most esteemed living authorities, and by many of the most eminent of those who have illustrated the science with their labours, the existence of what were supposed to be idiopathic fevers, or without local affection. This is a question that remains to be decided, and can alone be accomplished by a careful study of the phenomena manifested in fevers, and a frequent appeal to autopsical researches for the elucidation of the local lesions and their nature.

Inflammation determines at times on the mucous surface a false membrane. The degree of inflammation by which this membrane is produced, is often very low, but it is seen to occur in all its degrees, from the lightest to a phlegmasia gangrenous from its intensity. Bretonneau has given the name of dipthenteric, to this inflammation, which he regards as peculiar. The most frequent period of its occurrence is in infancy and childhood, though it is occasionally met with in adults. Is not the frequency of its occurrence in the earlier periods of life, like œdematous inflammation in debilitated and badly nourished individuals, an accidental circumstance, depending on the state of the sanguine or nutritive humour? It is then abounding in albumen and fibrin, which, from the activity of nutrition is the more disposed to be secreted in inflammation.

On the parts where an epithelium exists, the false membrane commences with small white laminæ of considerable density. In

other parts it is at first a tenacious lymph, which soon acquires consistency, and adheres with some degree of firmness to the inflamed surface beneath.

When there is an epithelium, the membrane terminates suddenly; in other portions it is gradually lost in a less viscid mucosity. When the inflammatory irritation by which this false membrane is formed, diminishes, mucus is secreted between it and the muciparous membrane. By this process it is loosened and is rejected either entire or in shreds. At other times, it becomes gradually thinner and semi-transparent, and finally disappears.

The formation of this membrane is due to an altered condition of the secretion of the cryptæ, as is proved by its occurring in membranes deprived of papillæ. This affection has been well understood only within a few years. It constitutes, when it occurs in the pharynx, the angina gangrenosa of older writers. It is the production of the false membrane in inflammation of the larynx and trachea, which is the peculiar feature of croup. The commencement of croup, or angina membranosa, is almost uniformly on the velum pendulum, internal cheeks, tonsils, &c.; and thence the inflammation and membranous exudation, pass into the larynx and trachea. The disease is inflammatory in its character, and is to be treated actively by antiphlogistics, revulsives, internal and external, as emetics, purges, blisters, and the direct application of caustics to the fauces.

This product of inflammation occurs sometimes in the mucous or villous coat of the stomach and intestines. Dr. Godman met with an instance of it in the stomach, in a subject brought into his dissecting-room. It is frequently discharged from the bowels, and has been mistaken for a portion of the intestines from its tubular form.

The cryptæ or mucous follicles that abound in some portions of the mucous membranes, become the seat of inflammatory irritation. They then enlarge, are turgid with a vitiated secretion, and assume a pustular form. This circumstance has been seized on by ontologists, who delight in multiplying specific and independent diseases, to constitute a specific inflammation, and which has been named pustular inflammation. M. Bretonneau, of Tours, has taken the trouble to coin for it the difficult cognomen dothinen-

teritis. In the numerous instances in which pustules in the intestinal mucous tissue, are met with in my autopsical examinations in the Alms-house Infirmary, I have never known one in which they could be regarded as a primary disease, but as succeeding to or accompanying erythemoid inflammation.

The pustules that occur on the muciparous membranes have two principal forms; the first is rounded, projecting, and more or less acuminated; they are the simple development or enlargement of the follicles. The second is a flattened lamina, more or less elevated, and are formed by the aggregation of numerous inflamed muciparous glands. The flattened laminæ, are, I believe, peculiar to the small intestines, and are most frequent in the ileum. In its lower third portion, no other structural derangement is of as common occurrence. I have not met with them in any other part of the mucous tissue. The lamina of which we speak are of various sizes, and almost uniformly of an oval shape, from half an inch to two inches in length, and from a fourth of an inch to an inch and a fourth in width. They are not formed by a swelling or tumefaction of the membrane gradually elevated, but rise perpendicular from the surface of the intestine, and are from a line to two lines in thickness. The superior surface of the lamina is flat; when recent they are red; though as the inflammation assumes a chronic character, they acquire a pale gray. The colour is not confined to the exterior, but penetrates the whole substance of the lamina. The villous coat around them is sometimes inflamed, yet it often is in a natural state. The surface commonly is rugose and unequal, and the villi are obliterated. The villous tunic is converted in part into a soft, spongy, red, cellular tissue, infiltrated with dark blood and gelatinous lymph, when the inflammation is recent; and with a coagulable, gelatiniform, or puruloid fluid, when it has been prolonged any length of time.

Pustules and ulcerated laminæ are observed in the fatal cases of what has been termed catarrhal fevers, the febris mucosa of Stoll and Pinel—the slow nervous fever of Huxham, and the group of symptoms designated as typhus mitior of Cullen. In cases of this character, I have found uniformly the cryptæ of the gastro-intestinal mucous membrane inflamed, enlarged, forming pustules in various stages from a small pimple and perfect laminæ to com-

plete ulceration. They are often filled with a mucoso-purulent fluid which exudes when they are squeezed.

This pustular condition of the gastro-intestinal mucous membrane, in the form of fevers I have mentioned, was first noticed by the German writers Rœderer and Wagler, in their History of the Epidemic or Mucous Fever of Gottingen. It is always accompanied with increased secretion of the cryptæ, and it is to the prolonged secretory orgasm, maintained by irritating causes, especially purgatives, that their inflammation and structural change are to be attributed.

The pustules of the intestinal mucous membrane frequently exist in a chronic state of inflammation, and the diseased follicles run into ulceration. This condition prevails in nearly all the cases of chronic diarrhœa, especially when succeeding to fevers or dysentery.

The production of pustules in the tegumentary membrane, both external and internal, and which are local phlegmasiæ, show most clearly that inflammation may be excited in isolated points, or in distinct capillary fasciculi, and may be restricted to a single component of a compound tissue.

The pustules found in the internal mucous membranes in fevers, are by some writers, especially the English, supposed to be an effect of the fever, and unconnected with any primitive local irritation, that excited the phenomena or symptoms called fever.

It has been shown that these pustules are local phlegmasiæ, or inflammation of the cryptæ or mucous follicles.

Now, that fever should excite these numerous points to an increase of their normal actions, which in fact, constitutes inflammation, it must be capable of immediately irritating them, of acting as a substance, as possessing an essential existence, of having being. The phenomena of fever, it will be shown, are only symptoms arising from sympathetic irritation of the heart; when this subsides, the group of symptoms to which the term fever strictly belongs, immediately disappear. The primitive local irritation that constitutes what are called essential fevers, is in a majority of cases, the erythemoid inflammation of the gastro-intestinal mucous membrane. From this point are irradiated the morbid impressions that involve other organs, giving greater or less extension and complexity to the original phlogosis, according to its in-

tensity, the irritability of the individual, and the more or less previous healthy condition of his organs. When the gastric irritation, or the erythemoid inflammation of the gastro-mucous tissue declines in intensity, or altogether ceases, either from an appropriate treatment or other causes, the irradiated or sympathetic irritations also decline, and the organs which sympathized in its irritations, return to their natural condition: then the pyretic or febrile symptoms disappear. Should the erythemoid inflammation, however, have extended into the lower portion of the ileum and the large intestines, and assumed there a chronic state, or produced inflammation of the mucous follicles or cryptæ, as the sympathetic connexions of these organs are few and inactive, and do not immediately affect the heart, exciting and disturbing its actions, no febrile symptoms are manifested or are re-awakened. The symptoms that result from the chronic inflammations, and the inflammation of the follicles of the ileum, cœcum and colon, and their ulcerations, appear then to be secondary to the febrile symptoms, although they were absolutely in the commencement concomitants. It is this circumstance that has led the writers to whom I alluded, to assign the pustular and ulcerated state of the ileo-cœcal and colitic mucous membrane in fevers, as an effect of fever, and not as a primary or concomitant local affection.

Inflammation of the internal teguments, or mucous and mucoso-villous membranes, exists very frequently in a chronic state. A great variety of morbid phenomena depend on this condition of the different portions of the mucous system, often obscure in character, perplexing in treatment, the opprobrium of the profession, and despair of the patient.

The anatomical characters of chronic inflammation of mucous membranes are diversified. They vary with its intensity and the period of its duration.

These characters consist in changes of the colour, of the secretions, and of the structure of the mucous tissues.

In the gastro-intestinal mucous membrane, chronic inflammation may be divided into three states or degrees.

The first, which partakes to a certain extent of the acute character, and is accompanied with many of its symptoms, produces a colouring of the mucous membrane, varying from a uniform deep red, which becomes of a light scarlet when exposed to the air, to

a lighter and more partial redness, accompanied with capillary injection. The membrane is not turgid, is sometimes softened in consistency, and is covered over with a viscid and sanguineous mucosity.

The second degree in which the inflammation is simply chronic, exhibits in the mucous tissue a slate-colour of different shades, intermingled with violet or a marbled appearance. The tissue is considerably changed, most usually being thickened, and the villi have disappeared. The deeper the grayish hue, the more dense and thicker becomes the membrane. It is not uncommon to find in the gastric mucous tissue, in this degree of inflammation, numerous ink-black spots of different sizes, and penetrating into the coat to different depths.

The third or last state of chronic inflammation, which is probably rather an irritation of long continuance, that has scarcely acquired the characters of inflammation, and which is gradually induced, manifests in its anatomical character a grayish-white colour of the mucous tissue, which is dense, thick and firm, and adheres with force to the subjacent tissues. It often grits when divided with the scalpel.

The increased thickness and density of the mucous tissues, resulting from inflammation, materially deranges the important functions of which they are the seats in different organs—as respiration in the bronchiæ, digestion in the gastro-duodenal apparatus, &c. This is one condition giving origin to some varieties of asthma, dyspnœa, chronic bronchitis, and of dyspepsia or indigestion.

The sensations are often rendered morbid by chronic inflammations, and it becomes exceedingly difficult to distinguish the painful feelings thus excited, from purely nervous pains or neuralgia. The treatise of Barras on gastralgia, which has been greatly overrated, is calculated to do much mischief, by confounding simple gastralgia or neuralgic pains in the stomach, comparatively a rare disease, with pain in the stomach, caused by chronic inflammation and the structural derangement of its mucous tissue.

The secretion of these tissues suffers a morbid change. The mucous is rendered more viscous, becomes of a grayish colour, and puriform or purulent in character, even when no ulceration exists. The serous exhalation in moderate chronic inflammations

is not augmented, but becomes very abundant when the inflammation increases in energy: this state exists in chronic diarrhœas.

By the supervention of acute inflammation on chronic inflammation, the hardened consistency of the tissue is changed, and it softens so as to lose almost entirely its texture. It is often found in these cases infiltrated with purulent fluid, or to contain numerous disseminated small abscesses. The persistence of the acute inflammation very speedily induces ulceration, and should it decline after purulent infiltration, the mocoso-villous membranes soften to a degree as to become nearly diffluent.

The mucous tissues reddened or darkened by chronic inflammation, do not lose their colour by maceration or washing; nor do artificial injections penetrate their capillary vessels, or even the engorged branches surrounding and traversing the seat of the phlegmasia.

Chronic inflammation of the mucous membrane, to which these changes of structure are owing, in a vast number of cases, is primitive in its origin, but sometimes succeeds to acute inflammation. The early symptoms induced when it is primitive, are so slight they are seldom attended to, or are wholly neglected by patients, who seek the assistance of art only when the increase of their sufferings has compelled them to look for relief, and when it is too late to remedy the disorders of structure that have been already accomplished.

Acute inflammation may supervene on any of the states of chronic inflammation described, or in any of the morbid changes of structure it has produced. It is always then more difficult to cure, and most frequently produces speedy disorganization. This is especially true of the changes succeeding to slow inflammation. Phagedenic or sloughing ulceration rapidly ensues on acute inflammation occurring in the tissue, that is in this morbid state.

Conversion of mucous into cartilaginous, and as is sometimes met with, into osseous tissues, and the development and growth of polypous excrescences and cancerous degeneration, are varied effects that result from chronic inflammation, when it is permitted to be long protracted, and especially when treated in an inappropriate manner.

Ulceration is a frequent consequence of inflammation in the

tegumentary tissue. In no other tissue is this effect of so common occurrence, especially that of a phagédenic character.

Ulceration occurs with great rapidity when it succeeds to acute inflammation, and more especially when it is caused by acute, engrafted on chronic inflammation; or it is excited in a part whose structure has passed into a state of degeneration.

The mucous tissues do not appear to be equally susceptible of ulceration in all their portions. It is common in the mouth, tongue, pharynx and nostrils. It occurs, although more rarely, in the larynx and trachea. I have never found it in the bronchiæ, or have met with an instance of it recorded by any writer.

In the digestive tube considerable difference is observed in this respect. The portion in which ulcers are most common, is the lower third of the ileum and the cœcum, particularly in the immediate vicinity of the valve; next to this is the termination of the colon and commencement of the rectum—the stomach succeeds next in the order; then follows the arch of the colon, the jejunum, and last, the duodenum. I have not as yet in my examinations, seen a single instance of ulceration in the two last.

Ulceration occurs in different manners, and exhibits different aspects. It may result from erythemoid inflammation; it is then superficial and circumscribed, and is generally covered over with a white puriform layer.

It succeeds sometimes to the pustules that have been described; the walls of which ulcerate after the matter secreted in them has been evacuated. The membrane presents in some of these cases the appearance of a strainer, being perforated with an innumerable quantity of small foramina.

The last form of ulceration is that which takes place in the laminæ, composed by the agglomeration of the inflamed follicles. They first soften, small erosions appear on the surface, which extend with rapidity, and the whole lamina is soon involved in ulceration, and destroyed. The edges of the ulcers formed in this manner are perpendicular, rugged, swelled and projecting round the circumference. The smaller ones possess a strong resemblance to the description Hunter gives of the venereal chancre.

The ulceration penetrates to different depths. Frequently it does not extend beyond the mucous tissue, though it often destroys both it and the muscular coat, having the serous tunic for

its base. This last is then seen frequently to thicken, it inflames, throws out coagulating lymph, which unites it to adjacent portions of the intestinal tube, or to the parietes of the abdomen. In this manner, the perforation of the canal and the extravasation of its contents, are effectually guarded against.

This perforation does, notwithstanding, occur in many cases, when the inflammation is exceedingly intense, and the ulceration rapid; or when acute inflammation ensues in a part of the canal that had been previously the seat of chronic inflammation.

This irreparable accident is announced by the sudden accession of peritoneal inflammation in the most intense degree, accompanied with excruciating pains, rapid prostration and the speedy dissolution of the patient.

Inflammation of mucous membranes, under particular circumstances, assumes a strong disposition to eventuate in gangrene. Extensive, rapid, and mostly fatal disorganizations are then produced. Inflammation of this character is frequently seen in the bucco-pharyngian mucous membrane, and especially occurs in this location in infants and children. In the children's asylum attached to the Alms-house, it has manifested itself almost in the epidemic form, and proved fatal in a great number attacked by it. This gangrenous disposition is characterized by the appearance of small phlyctenæ on the mucous membrane of the mouth, gums and pharynx, which is of a deep livid red, and considerably tumefied. When the phlyctenæ break, they are succeeded by blackish-gray escars, that extend rapidly into the adjacent parts, destroying the gums, the parietes of the mouth, and often perforate the cheek. When the thickness of the cheek becomes affected, it swells very considerably, is renitent, and of a glossy appearance.

The gangrene commences sometimes with grayish ulcerations, the bucco-pharyngian membrane being of a pale red, but tumid and soft. The edges of the ulceration are livid and elevated; the ulcers are covered with whitish, soft, extremely fetid membranous layers, and discharge a fetid corrosive sanies. They progress rapidly, destroying all the adjacent soft parts, and sometimes the bones do not escape the ravages of the disease.

Gangrene may occur in any of the mucous tissues, though the bucco-pharyngian is its most frequent seat. It has been met with in the œsophagus, a portion of which has been totally destroyed, and in the mucous membrane of the stomach and intestines. Next to

the mouth, the ileum is the seat in which it most frequently exists. When it is limited to a small extent, as situated in a lamina such as has been described, all the tunics of the intestine may mortify in a very short space of time, and the symptoms of peritoneal inflammation, caused by the effusion of the contents of the bowels, supervene, under which the patient rapidly sinks.

This species of perforation is not to be confounded with another kind, denominated spontaneous perforation. This last is by no means unusual, especially in children, and its most common location is the stomach. It has been supposed to arise from the digestion of the coats of the stomach after death. The marks of acute inflammation are not generally very obvious, whence it has been conjectured to be independent of any inflammatory action. This softening of structure, to which spontaneous perforation is owing, is, I have no question, one of the effects of inflammation. I have seen it in the liver and brain under circumstances, leaving no doubt as to the inflammation of the organ having preceded its softening.

When gangrene occurs from the erythemoid inflammation of the mucous membranes, it generally extends over a large surface, and does not involve the other tunics of the intestines. I have repeatedly met with this circumstance in acute enteritis, iliac passion, and in some malignant fevers. The mucous membrane is then black, almost diffluent, can be scraped off with the handle of the scalpel or nail, is excessively offensive, and the intestines are filled with a blackish or bloody mucus.

Sect. X.—*Glandular Tissue.*

The glandular system is composed of organs having usually a rounded or ovoid shape; they are lobulated in texture, having an intrinsic vascular system appropriated to the secretion of peculiar fluids. These fluids are collected by excretory canals or tubes, ramifying through the substance of the glands, and which reunite to form a single trunk, through which the product of secretion is poured out on the surface of the integuments.

The following are those regarded as true glands, and are alone embraced in this system. The salivary and lachrymal glands, the liver, the kidnies, the mammary glands, the testicles, and by some, the ovaries.

The mucous and sebaceous follicles or cryptæ are, however, fully entitled to be considered as glands, and as belonging to this system. They furnish the prototype of the glandular formation. The follicles or cryptæ are simple sacs, provided with a narrow neck, and opening on a mucous tissue. They are depressions or continuations of the mucous membranes, by which arrangement the mucous surface, in a given sphere, is very greatly enlarged.

The mucous tissue is prolonged, as was previously announced, through the excretory ducts, in the more complicated glandular structure, and forms in the interior of the glands numerous small sacs, around which the capillaries are collected.

The mucous follicles prolonged, ramified, and their ramifications intermixed with vessels, would give the structure of the most complex of the glandular system.

The glands are found in the trunk extensively; some are in pairs, placed on each side of the median line, as the kidnies, mammary glands, testicles, &c. Some are single, and placed on this line, or on one side of it, as the pancreas and liver. Their excretory canals are prolongations of one at least of the integuments of the mucous tissue.

The glands vary from each other in many particulars. They are of very dissimilar size, which is seen in comparing the liver, one of the largest of the organs of the economy and the lachrymal gland. They differ also in colour, the liver and kidnies having their tissue coloured, while the others are white.

The glands are enveloped in cellular capsules of greater or less density, having in some a fibrous consistency. It penetrates into the interstices of the lobuli and granulations of the secretory organ. The cellular tissue conducts the vessels that enter the glands, into the interior of its substance; and they do not unite with its proper tissue, except in the last ramifications.

The glandular structure or parenchyma is composed of vessels, lymphatics, some nerves, chiefly derived from the ganglionic system, and excretory canals, re-united in their minutest ramifications by cellular tissue.

Secretion, which is the function of the glandular tissue, is performed in its interior structure, and escapes immediate or direct perquisition. Ruysch considered the glandular capillaries as continuous into the excretory canals, and that the secreted fluid was

thus poured directly from the blood-vessels into the excretory ducts. Malpighi, on the other hand, asserted that vesicles exist between the vessels conveying the sanguine fluid into the glands, and the excretory ducts that carry out of them the fluids they secern. That this precise structure exists, has not, most certainly, been demonstrated, and most probably does not exist.

Comparative anatomy, and observations made on the development of the glands in the embryons of superior animals, demonstrate that the excretory ducts are first formed, the ramifications of which terminate in closed extremities or pouches. The vessels or capillaries, nerves and cellular tissue, are subsequently formed around them, and thus compose the gland.

These circumstances would appear to establish, or at least to authorize the conclusion, that the glandular tissue belongs to the tegumentary system, or of the mucous membranes; consisting of elongations of that tissue, ramified and formed into ducts or canals. Secretion consequently takes place in, or is performed by the follicles that exist in this ramified membrane, as we see it to be accomplished by follicles or cryptæ, existing in the general mucous membranes, as of the fauces, bronchiæ, alimentary canal, &c.

The glandular tissue in general, possesses a very low degree of sensibility: this property is manifested most acutely by the testicles when compressed. This structure is, however, highly irritable, and is frequently affected with diseases of irritation.

The functions of the glandular tissue is the separation or secretion of peculiar fluids, different in each gland.

Secretion will be considered hereafter; it differs from perspiration and follicular secretion only in the greater complexity of the apparatus.

The glandular system is subject to numerous morbid alterations, most of which are the consequence of its acute or chronic inflammation. This morbid state presents various characters, from the secretory orgasm or excitement, which is its first rudiments, to inflammation of the highest grade. In the greater number of the instances of glandular inflammation, the irritation that produces it, is not in the first instance, developed in the interior or substance of the gland, but in the mucous surface on which its excretory duct comes to terminate.

That irritations are in this manner communicated to the glandular organs, is placed beyond all question by the result of numerous and familiar observations.

This is the manner in which medicinal agents affect the glandular tissue. Irritation excited in the buccal mucous membrane, as by the radix pyrethri, tobacco, &c. produce increased discharge of saliva, by stimulating the parotid and sublingual glands through their ducts, which terminate on that membrane. Before a mercurial salivation is induced, it is always preceded by inflammation of the mucous tissue of the gums and cheeks, and the irritation produced in them, is transmitted to the glands through the salivary ducts.

When large and reiterated doses of drastic purgatives are exhibited to animals, which provoke an irritation on the duodenal mucous membrane, they occasion bilious evacuations. The liver, it is asserted, acquires a deep reddish brown or chesnut colour; when divided, numerous yellow points are seen on its surface, and the mucous tissue of its excretory ducts presents a rose tinge. The vascular ramifications are besides, highly injected.

Mammary abscesses are frequently produced by small sores on the nipple. The irritation they excite is then continued through their ducts into the interior of the gland, where it lights up inflammation, ending in suppuration.

These facts are quite sufficient to establish the principle, that irritation and inflammation of glands may, and renders it probable, that in most instances they do arise immediately from the irritation of the mucous surface, with which they are in immediate connexion by their excretory ducts, and not from an irritation originating in the proper structure of the glands themselves.

The effect of inflammation on the secretions of the glands depends on the intensity it assumes. When it is slight, the secretion is augmented, and differs little, if any, from its physiological state. It may be less perfectly elaborated, and with a slight increase of the inflammatory action, it becomes serous or sanguinolent. The inflammation passing to a higher degree, the secretion diminishes, its product becomes highly acrid, and is often mixed with blood. Acquiring a more active state, the secretion is entirely suppressed in the part in which the inflammation exists.

The texture of the glandular tissue is variously affected from its inflammation. Suppuration is established with difficulty. The cellular tissue separating the lobuli, when it becomes irritated in inflammation of a gland, exhales, as elsewhere, a serosity by which it is distended. The lobuli, or small granulations of the gland are in consequence separated from each other, and numerous distinct points of suppuration are established. I have seen the liver when death has occurred from acute hepatitis, infiltrated as it were with pus, without a collection as in an abscess. In one instance innumerable points of suppuration existed, from the size of a pea to that of a hazel-nut.

In more intense inflammation, the proper tissue of the glands softens and suppurates, and collections of matter are formed. The suppuration in some instances, I believe, commences in the mucous lining of the excretory ducts.

A case that came under my observation in the Alms-house Infirmary, appears to establish this point. A black man who had suffered repeated attacks of pain in his right hypochondrium, accompanied with fever, was admitted after several days illness, with all the symptoms of acute hepatitis. He died in the course of the week of his admission. The liver, when the body was examined, appeared turgid, was larger than natural, and no doubt existed that an abscess would be discovered in its interior. None was detected, nor were any purulent points to be perceived. But on making pressure, pus of a thick consistency escaped from the pori biliarii in every part of the liver.

Softening is an alteration of the glandular tissue that frequently occurs. In every instance in which I have met with it, acute inflammation of the organ prevailed at the time.

Chronic inflammation of the glandular tissue is a frequent accident, and generally occasions its induration, by the vitiation induced in its nutritive actions. This induration is usually accompanied with change in the colour, as well as consistency of the glands, and they often become schirrous or carcinomatous; this transformation is more especially induced in the testicles and ovaries.

The deposition of fat in the liver, or the conversion of its substance into a fatty matter, is an effect that at times results from chronic inflammation.

Sect. XI.—*Muscular Tissue, or System.*

The muscular system is composed of organs formed of contractile fibres, which occasion movements of more or less extent, and are the agents of locomotion.

The muscular system offers differences so considerable, it may be divided into two classes. The first is arranged on the exterior, has its fibres collected into masses of varying size, and obeys the influence of the will. These are the voluntary muscles, designated by Bichat, as the muscular system of animal life. The second is interior, and consists of membraniform muscles belonging to the viscera, and do not obey the will. They are the involuntary muscles, or those which are termed of organic life by Bichat, and vegetative life by others. With the exception of the heart, they are whiter than those of the first class, and are spread beneath the mucous membranes.

The muscles are assemblages of fibres, primitively microscopical, but which reunited form visible fibres. These are again united by means of a soft, delicate cellular tissue into bands or lacerti, which united to others still larger, constitutes the muscular substance.

The first, or primitive fibre, is generally regarded at the present day as slightly flattened, composed of a series of globules or corpuscules united together by a transparent gelatinous substance, and which are exactly analogous to the globules of the blood, deprived of their colouring matter.

The muscles are abundantly supplied with vessels and with nerves. The number and caliber of the vessels are proportioned to the volume of the muscles.

The same muscle sometimes receives several nerves. When this is the case, it has been clearly established by Charles Bell, that the muscle is employed in several kinds of movements, or the performance of different functions. The muscles of animal life receive nerves from the cerebro-spinal apparatus, while those of organic life are derived chiefly from the ganglionic system, but receive some supplies from the cerebral system. The first generally predominate, unless it be in the stomach, to which the par vagum or pneumo-gastric furnishes a liberal supply.

The muscular tissue varies in colour from a grayish-white to a

deep red, according to the class in which it exists. The membraniform muscles are whitish. The colour is always deeper in the thickest muscles, which is not owing to their vascularity, but the presence of a colouring matter analogous to that of the blood.

Fibrin is the principal constituent of muscular fibre, and is precisely analogous to the fibrin of the blood. The globules of both are apparently identical, and there is every reason to conclude they are of the same nature.

The muscles possess but a very moderate degree of sensibility; it increases, however, in certain morbid states, especially in their inflammation.

They enjoy in a very exalted degree the power of contractility, which is the irritability of Haller, and is the property on which depends the part they perform in the animal economy. These contractions are excited in the muscles of voluntary motion by the will, by galvanism and other irritants, acting on the nerves distributed to them.

The involuntary muscles have their contractions determined physiologically, by the contact of certain agents, as the blood for the heart; the aliment, chyme, chyle and excrementitial residue, for the membranous muscles of the digestive canal.

Emetics and purgatives are excitative of their contractions, and in this way is accomplished artificial evacuations of the contents of the alimentary tube.

The morbid alterations of this system are but few. The natural excitant of the muscles is nervous power, and they are exempted from the immediate impressions of the numerous foreign agents and aggressions to which the other organs, especially the tegumentary system, is exposed.

Inflammation of the proper muscular fibre is considered as a problematical circumstance. That of their cellular tissue is frequently observed, and even purulent collections are found between the lacerti or bands of which it is composed. In some muscles, a considerable tumefaction arises from the capillary injection and purulent effusion, that are a consequence of their inflammation, as in glossitis or inflammation of the tongue, when the tumefaction of this organ is so great as to endanger suffocation.

The inflammations of this tissue receive different denominations, according to the part affected. In the muscles of the chest, it is

called pleurodynia; in those of the loins, lumbago; in the heart it is named carditis; in the tongue, glossitis. With the exception of the two last, they are all designated as muscular rheumatisms.

The nutritive function of the muscular tissue is frequently in morbid excess, and is an effect of a chronic irritation, maintaining a too vigorous capillary action in its tissue: an affection is the result of this condition, that is named hypertrophia.

The muscular structure of the heart is very commonly affected in this manner, more particularly the ventricles; and one alone, (the left most frequently,) or both, may exhibit this morbid phenomenon. Great disorder in the function of the heart necessarily follows this departure from its natural condition, which carries extensive disturbance into the other functions of the economy, and shortens the existence of the sufferer. I met with this state in the muscular coat of the intestines, in the body of a man who had been treated, during eighteen months, with active hydragogues for a dropsical effusion.

The very opposite condition is observed to occur in this tissue, which is the wasting or the atrophy of the muscles. Most commonly it results from their complete inaction, as in paralysis, and is then probably a mere deficient nutrition, from the debility or asthenia of the organic actions. It is then a symptom, and not a disease.

The voluntary muscles are subjected to cramps or partial convulsions, to general convulsive movements, and to contractions of various intensity. In these affections, the disease is not to be looked for in the muscles: their disorder is only a symptom. In the convulsion of a single muscle or cramp, it is an irritation of a single nerve, by which it has been induced; and in more general convulsions and disordered contractions of the muscles, as in tetanus, epilepsy, chorea, &c. the brain or spinal marrow are to be regarded as the actual seat of the morbid lesion. From the system of the voluntary muscles, or of animal life, we derive our most important diagnostic signs of the condition of the nervous organs. The muscles are to the nervous organs of the locomotive apparatus, or of voluntary movements, what the pulse is to the heart, and furnish to the intelligent practitioner the most certain indications of its actual state.

The muscles of organic or vegetative life are not highly endow-

ed with irritability, and are rarely, probably never affected, excepting the heart and uterus, with irritations, unless consecutive to those of the mucous membranes by which they are covered.

The muscles of this class are not subject to be paralysed, as are those of animal life. The stomach may probably be an exception to this observation, but it is largely supplied with cerebral nervous power by the pneumo-gastric one of whose offices it would appear to be, is to maintain the muscular activity of the stomach in digestion, by which the food is brought and kept in constant contact with its parietes. The suspension of digestion when this pair of nerves is divided, may arise from the paralysis of the muscular coat of the stomach, in consequence of which the food remains motionless in the stomach, and often regurgitates into the œsophagus, and from which it passes sometimes into the larynx, causing suffocation, one of the modes of death in this experiment.

The membranous muscles yield often to distending causes, as gases, liquids, or solids, accumulated in the cavities to which they belong, in a manner that might lead to a suspicion they were in a paralytic state. The stomach and intestines are in some instances enormously distended, and their functions are interrupted by their incapacity to act on their contents. This state is rather a symptom than a disease. It is seen to occur in the advanced stage of acute gastro-enteritic inflammation, and is a very common accompaniament of the chronic forms of gastro-enteritis. The same distention is often witnessed in the bladder, which becomes incapable of expelling its contents. By drawing off the urine, however, its contractility is restored.

The muscular fibres of the heart often yield to the distention caused by difficulties obstructing the circulation, and occasionally when no obstructing cause can be detected. The cavities increase in these cases more than double their usual size, while the parietes become thinner, constituting passive aneurism, or more properly, dilatation of the heart.

The involuntary muscles are probably the seat of neurose or nervous irritations. Vomiting, with severe pain in the epigastrium, unattended with sympathetic disturbances, no disorder of the circulation, heat of the skin, &c. are probably of this character. Some few cases of diarrhœa, such as result from moral causes, and spas-

modic colics unattended with inflammation, are to be regarded in the same light. The heart is indubitably often the subject of neurose disorders, as certain palpitations, angina pectoris, and it is not improbable, it may be affected with sudden and fatal spasms.

In the preceding pages has been presented the general history of the tissues or systems, that enter into the composition or constitution of the organs of the economy, with the principal morbid lesions to which they are subject, and the characters by which these are accompanied.

In this investigation I have derived most important aid from the General Anatomy of Bichat, and of Chaussier; from the Traité General d'Anatomie of Meckel, and from Gendrin's very excellent work, Anatomie des Inflammations. From this last I have differed in rejecting his specific inflammations, which I cannot but regard as a remnant of ancient prepossessions, and of the correctness of which I have not found confirmative testimony in the results of my own researches and observations, made in an ample field opened to me, in the practice and autopsies of the Alms-house Infirmary of this city.

It cannot be necessary at the present day to vindicate the preceding method of regarding the organic solids and the animal economy. The anatomical doctrine of Bichat is founded in a correct observation of nature, and is received by all unprejudiced anatomists and physiologists. Whether we study the tissues in their anatomical form, chemical nature, physical properties, physiological functions and morbid phenomena, we are presented with the most decisive evidences of their distinct nature and character. They must then be looked on as the anatomical or animal elements, of which the organic solids are proximately formed, and as such, must constitute the basis of every system of physiology, pathology and therapeutics, that have pretensions to a natural method, or to repose on attested facts.

The sketch that has been presented of the tissues, their structures, functions and morbid lesions, for a higher title cannot be claimed, is slight, general and imperfect. I would, however, earnestly enforce on my readers the importance of making them the subject of more deliberate study and profound investigation. The more perfect is our knowledge of the tissues, the better we shall be enabled to investigate diseases, to understand the value

of symptoms and to direct a plan of treatment. It will be found available in every case the practitioner is called upon to take charge of, and without this information, he is not competent to decide on the merits, or even to comprehend the principles of the systems of the present day, (physiological and organic medicine,) based on considerations derived from the vital properties, the organic actions and the anatomical structure of the organism, or animal economy: it cannot be said, in the actual state of the science, that he is adequately prepared for the exercise of the high and responsible functions of his profession.

It was before asserted and is now repeated, that in the animal and human economy, there exists only organs and functions, and all we do and can know of life is, that it is the organs in action. The functions cannot exist independent of organs; they are effects. Every alteration of function must, then, necessarily imply an alteration of an organ.

When the organs, their actions and the functions they execute, are in a normal state, health exists. This is healthy anatomy and physiology. When the organs, their actions and functions, depart from this natural or normal type, a pathological or diseased condition exists. This is morbid anatomy and physiology. Healthy anatomy and physiology; morbid anatomy and physiology, are propositions that embrace the whole science of medicine.

From the above propositions every disease must have a locality, every morbid cause a local action, and every medicinal agent must excite some modification in the action of some tissue or organ, whether our science enables us to detect them or not. Every symptom is the annunciation of a disturbance of functions; and disorder of function is the indication of an organic lesion, either in the mode of the action, or the structure of an organ. In every case of disease the practitioner is invited to treat, his first object must be to determine the organ or organs in a state of lesion; his second, the nature of the morbid physiological actions that actually exist; and his last, the therapeutic actions or modifications he can accomplish by his remedial means, that are compatible with the morbid condition of each of the organs. But to arrive at these ends, he must be familiar with general or analytical anatomy; that is, with the organs that compose the animal economy, and the tissues and systems which are the proximate elements

of the organs; with the appreciable actions that immediately depend on the vital properties; with the functions or offices of every organ; with the nature of the modifications carried into the actions and structures of the tissues, by various morbific agents productive of disease, and the subjects of the materia medica and hygienic regulations, by which he can best counteract and oppose their departure from a natural state.

New facts may hereafter be established, and new discoveries effected in medicine, of which we can now have no comprehension, and which may impart an entirely different aspect to the science. But with our present knowledge, I cannot understand any other method than that I have indicated, by which fixed and positive ideas can be acquired, or the principles that can alone make medicine a science be unfolded.

CHAPTER II.

Of the Fluids.

The organism, it has been said, is composed of solids and fluids, between which is maintained an unceasing molecular action during life, and between which exist a reciprocal and most intimate connexion; the two being mutually dependent on each other.

The mode of being and conservation of living bodies, which is a nutrition, that is, an incessant molecular composition and decomposition carried on in the intimate texture of all their parts, necessitates the fluid condition of the animal elements, in one stage of their existence. Hence the fluids have been named organic fluids or humours.

The fluids are contained by the solids, formed into vessels and reservoirs, or in the vacuities of the areolar tissues and the interstices of the animal structure. They present considerable differences in their appearance, chemical nature, mode of production and uses. Like the solids, they offer the basis of a classification. Several have been attempted. That of Adelon and Beclard, may be adopted, as comprising a natural arrangement.

By these physiologists, the fluids or humours are referred to three classes, the humours of absorption destined to form the blood; the special nutritive humour or the blood itself; and the secreted humours proceeding from the blood.

1. Humours of absorption. The matters destined for the nutrition of the body, are absorbed in the first instance, and elaborated into a fluid. Proceeding from two sources, they may be divided into two kinds; 1st. Into the humours of external absorption, composed of the nutritious matter derived from without; and 2d. Humours of internal absorption, or those composed of the matters derived from the economy itself. This last absorption is of twofold character, as performed by the lymphatics, and by the veins. The humours of external and internal absorption are three, chyle, lymph and venous blood.

2. Humour, especially nutritive. The preceding humours, or those of absorption, subjected to the action of oxygen, in the lungs, or respiratory apparatus, are converted into the humour placed in this class. It is the arterial or red blood, constituting the material employed in the nutrition of the body, from which proceed, with one exception, the secretions, and which is the principal agent of calorification, or the production of animal heat; it is immediately subservient to the evolution of nervous activity or power, in all its modifications; is the energizer of the organic actions, and sustains in a direct manner all the vital phenomena of the organism.

3. Secreted humours. These are numerous, and with a single exception are formed from the arterial blood. Their uses are very different, and they may be subdivided, after the manner of their elimination, or the kind of secretory organ, from which they proceed into three divisions. 1st. Perspiratory, or exhaled humours; such are the cutaneous and pulmonary transpirations, serous and synovial humours, fat, humours of the eye, &c. 2d. Follicular humours, or those secreted by follicles; as the mucus of the different mucous membranes, cerumen, ciliary humour, &c. 3d. Glandular humours, secreted by the glands, furnished with excretory ducts; as the salivary, pancreatic, lachrymal humours, bile, urine, milk, &c.

The animal fluids are not simple substances, but like the solids, are composed of chemical elements and organic elements,

and which are the same as those of the solids. This must necessarily be the case from the reciprocal dependance existing between the two. The solids by nutrition, are all formed of the fluids; and as they decompose, they enter into and constitute no inconsiderable portion of the fluids. Thus the solids are formed from the fluids, and the fluids from the solids.

In another relation, the mutual dependance of the solids and fluids is manifested. None of the fluids are received immediately from without the body. They are formed within it, and by the action of the solids. Each fluid is elicited by an organ. Chyle, which is a fluid of external absorption, is still elaborated by the stomach, intestines and lacteals; lymph by the lymphatics; venous blood in the capillary vessels and molecular structure; arterial blood by the capillaries of the lungs; mucus by the follicles of the mucous membrane; bile by the liver; urine by the kidneys, &c. While the fluids are thus the product of the action of the solids, they are also the natural stimulants or excitants, by which the organic actions of the solids are excited and maintained.

In treating of the organization, the two cannot be separated and regarded as unconnected. They pass into each other, in a manner that does not permit us to fix their limits; to designate the commencement of the one, and the termination of the other. They hold an equal coadjuvancy in every organic action, and the performance of every function. With this intimate connexion in the healthy condition, can they be separated in disease? Unquestionably they cannot: being an element of the organic actions, these must be modified by differences in the fluids or humours, especially of the nutritive humour; besides, the products that result from morbid action, being formed from this last, must be influenced and vary in their nature from differences in the constitution of this fluid.

Inattention to this element of the organic actions, and to the diversified results that differences of the nutritive humour or arterial blood, impart to the very same actions of the solids, has been one of the principal causes of the erroneous reasoning that abounds in the explanation of pathological phenomena; and has constituted no small portion of the difficulty in explaining the diversity of those phenomena, proceeding from the same cause.

At one period in medicine, the humours were considered the positive agents of all the morbid affections of the system; but what was then designated as the humours, were imaginary substances, having no existence, as atrabile, phlegm, &c.; or qualities that were equally supposititious, as alkaline, acid, putrescent qualities, &c. which were, on mere conjecture, believed to constitute the humours, or to reside within them, and whose excess or presence, constituted disease.

When a sounder philosophy brought into vogue the doctrine of the solids, the humoral pathology was entirely abandoned, and the concurrence of the fluids in disease was totally denied.

There can be no doubt that disease consists in unnatural deviations of the organic actions of the solids, but can these continue in a morbid or unnatural state, without changing the nature of the fluids, depending on the healthy organic actions and natural functions; and if changed in their character, must they not act as foreign or unnatural matters on the solids, maintaining irregularity in the organic actions and functions, or preventing their return to a natural state? Is it not from this cause that extensive irritations, fevers of great intensity, such as are usually called malignant fevers, in which the depuratory excretions have been for a considerable period suspended and the reparative functions, as respiration, digestion, &c. have been deteriorated, which must of necessity cause a less perfect elaboration of the nutritive sanguine humour, are so difficult to arrest in their course and so frequently prove fatal? Is it not from this cause that some local affections, particular ulcerations, &c. maintain themselves, from the nature of the fluids they secrete, which tend to perpetuate the morbid condition of the solids? The fluids, it is admitted, may be of secondary consequence in disease, but their influence deserves to be studied; it is probably too much overlooked.

Sect. I.—*Pathological states of the Fluids.*

A few observations on the pathological states of the fluids, may prove useful in directing attention to this element of the pathological condition of the organs of the economy. The fluids, it has already been shown, are constituent parts of the organism and enter into every action of an organ, as one of its integrant elements. That

the fluids are not invariably in the same state, but are susceptible of, and do undergo alterations, are facts too obvious to the most superficial observation to be denied.

The fluids may present three different deviations from a natural state, 1st. In their quantity, as being too great or too small; 2d. They may vary as to the proportion of their proximate or immediate elements; and 3d. They may be vitiated in nature.

§ 1. *Humours of First Class.*

Of the fluids or humours of the first class, or of absorption, the chyle, lymph and venous blood, our information is too imperfect to enable us to form any positive ideas on their pathological states. We are reduced almost entirely to conjectures. It is, however, by no means improbable, that an excess or deficiency of these humours may exist, and bring important modifications into the product of diseased actions. Thus it is easily to be conceived, that a lymphatic plethora may exist with deficiency in the red globules and fibrin of the blood; and this excess of the white lymphatic humour, or white blood, will affect most materially the phenomena of irritation and inflammation. They will present the characters of these states in a less marked degree; and their effects will be essentially varied. Is it not owing to a condition of this nature in the system, that in certain individuals, irritation and inflammation, obscure in character, are productive of albuminous exudations into the tissues, and occasion particular morbid degenerations of structure, or accidental formations? Is it not to this circumstance that common catarrhs and pneumonic inflammation, affecting individuals of the lymphatic temperament, so frequently terminate by the production of tubercles in the lungs?

Chyle too, it is by no means an improbable circumstance, may be deficient from an irritable condition of the mucous tissue of the small intestines, owing to which, the alimentary mass is too rapidly carried out of the system, as in lientery, and in consequence, the reparation of the nutritive portion of the blood be prevented.

It may also be perverted or vitiated in its nature. This humour, the product of the digestive organs, must in addition,

be affected in its nature by their morbid condition. The process of digestion is well known to be affected, disturbed and destroyed, by the irritations and inflammations of the organs concerned in this process; and its product must, under these circumstances, suffer in its elaboration. The nature of the alimentation will also exercise no inconsiderable influence on the nature of this humour. Aliment, deficient in nutritive qualities, or having injurious properties, may give rise to a deficiency of chyle, as to quantity, or may change its qualities in a manner to interfere with healthy hematosis or sanguification. This last circumstance would appear to be the cause of epidemic gangrenous ergotism, in some parts of France and Germany, when the bulk of the population, in unfavourable seasons, are compelled to subsist on rye extensively tainted with the ergot.

§ 2. *Humour of Second Class.*

The blood, or especial nutritive fluid, no one will deny, may be productive of a morbid state from existing in excess, or being deficient in quantity. The first state constitutes sanguine plethora or polyæmia; the last, anæmia or deficiency of blood. Both these morbid conditions have well marked characters.

The blood is the principal of the organic excitants, as well as the reparative element of the organs. When it is more abundant than is absolutely essential to the maintenance of health, it gives rise to functional modifications and disorders, that assume, at times, a morbid character. The face in this state becomes coloured, the lips, gums and buccal mucous membrane are of a bright vermilion; the eyes are brilliant and easily injected; the veins, especially those of the head, temples and neck, are prominent; the temporal arteries pulsate with force on exercise, or moral excitements; the skin is warm, soft, plump and humid; the pulse is full, strong, developed and frequent; epistaxis and other hæmorrhages attend on this state, and are easily induced; somnolency, fulness of the head, head-aches, ringing in the ears and other sounds are experienced; the sensibility and intellectual faculties are obtuse and dull; respiration is embarrassed and oppressed; costiveness prevails, and the stools are hard and dark

in colour. The urine is red, small in quantity and highly animalized in odour.

Anæmia, or deficient quantity of sanguine fluid, may result from various causes, become the cause of disease itself, or a modifier of the organic and functional actions. It is not less frequent in occurrence than its opposite state or plethora. It succeeds to hæmorrhages, to profuse secretory evacuations of every kind; or as the effect of a deficient alimentation, as consequent on chronic diseases, and sometimes, it has been said, from causes acting directly on the blood, as particular gases.

This state, or anæmia offers symptoms the very reverse of the preceding. The face is pale and colourless; sometimes it is swelled from effusion, particularly the eyelids; the lips, buccal mucous membrane, tongue and gums are white; the veins are very small, sunken and sometimes scarcely to be perceived; the skin is cold, dry and colourless; the trunk and limbs are diminished in volume, or are tumid and then pit on pressure; the pulse is small, feeble, slow or insensible; the heart beats rapidly from exercise, but the contractions are feeble and tumultuous, as though imperfectly performed. There exists also, vertigo, dimness of vision, numbness, syncopies from defect of cerebral or nervous excitement, with apathy, indifference, inattention, incapacity for movement, with great weakness and sinking on exercise. The respiration is slow and feeble, anxious and quickened by movement; the appetite is deficient; thirst is not experienced; the urine is copious, colourless and without odour.

This state comes on with more or less rapidity; most usually it is general, seldom local, and is of considerable duration. When it exists in women, amenorrhœa is an accompaniament, from the absence of one of the requisites of the menstrual flux, a certain degree of plethora.

Besides these two conditions of the nutritive or reparative humour, or blood, it may be effected in the proportion of its constituents.

The blood is composed of a serous fluid of a yellowish white colour, and globules of a vermilion or scarlet colour in the arteries, and a modena purple, or brown red in the veins. These different constituents do not hold the same proportion in all indivi-

duals, or in the same individual at all periods. The globules form the cruoric portion of the blood, and are immediately concerned in the nutritive process. It is also the more excitant part of this fluid, which is stimulating to the organic actions in proportion to its abundance. The serous part of the blood is that from which the exhaled or perspired fluids are immediately produced, and which sometimes exhibit all the characters of the serum of the blood. It can scarcely be a matter of doubt, that the greater or less predominancy of either of these portions of the mass of the blood, must influence very considerably the general state of the organic actions, nutrition and often the secretions. The cruoric portion of the blood diminishes considerably by abstinence; and Dutrochet asserts, he has seen the sanguine corpuscules totally disappear in a young toad kept for a year without nourishment.* This effect of abstinence on the cruoric portion of the blood, renders it the most efficient remedial mean in the treatment of chronic diseases, from the profound change it carries into the mode of nutrition.

A blood rich in cruor, or red concrescible particles, will give rise to inflammatory phenomena of greater activity or acuteness, than blood in which it is deficient. The one, too, will easily throw out membraniform exudations, while the other, with the same degree of vascular excitement, will be productive of serous exhalations or mucous secretions. It is owing to this circumstance that irritation and inflammation of the pleuræ in those who have laboured under chronic diseases, who have organs possessed of feeble actions, or are of the leuco-phlegmatic character, terminate in serous effusions, forming hydrothorax; while in those whose blood is abundant in globules and fibrin, coagulating lymph will be effused, forming adhesions.

The same effects are observable in the irritations and inflammations of the peritoneum. When they affect individuals of the one condition, with impoverished blood, ascites or peritoneal dropsy, is a certain and often very prompt result; in those of the opposite state, with exuberance of cruor and rich in fibrin, coagulable lymph is thrown out, and extensive adhesions between the

* Recherches Anatomiques et Physiologiques, &c. p. 209.

peritoneal surfaces of the abdominal viscera are formed; and they labour under the symptoms of acute peritonitis.

In irritations of the bronchial mucous tissue of individuals of the lymphatic temperament, or of those in whom hematosis has been defective, a fatal serous effusion into the bronchial air cells is often suddenly induced, unexpectedly carrying off the patient. This circumstance I have seen repeatedly to occur in patients, in the Alms-house Infirmary, who had long suffered under chronic intermittents, complicated with bronchial or pneumonic irritation. They were seized without previous difficulty of respiration, with the convulsive, laboured breathing of suffocation, and expired in a few hours. Examination invariably showed either effusion into the pleuræ which exhibited no signs of inflammation; or into the cellular structure of the lungs, which were solid and resisting, from the quantity of the serous fluid effused, and which flowed in streams from the stroke of the scalpel.

In persons having this condition of the circulating fluids, œdema and anasarca are the certain effects of often trivial irritations.

The blood, it is believed by many, experiences alterations in its character, the immediate consequence of disease. The extent of the morbid changes this fluid undergoes in disease, is not well understood, or the agency those changes exercise in producing morbid phenomena. This is a vast field of observation, that lies as yet almost a virgin soil, inviting to its cultivation, promising a rich and abundant harvest, and the most useful results to a cautious investigation.

The most striking and commonly observed alteration of the blood, is that which occurs in acute inflammations, and is termed inflammatory buff, crust, or size. This concretion is of a dull white or slightly yellowish colour, and sometimes is of a faint greenish tinge. The causes that lead to the formation of the inflammatory size are not well understood. It would appear to depend immediately on an increased energy of the innate force of the globules, that imparts to them a tendency to unite and agglomerate together; a force which is predominant in the solids, and by whose action they are formed: or by a diminution of the repellent force that tends to separate them, which is ascendant in

the fluid state, and causes the globules in that state to repel each other.

From the quantity and tenacity of the size, and the degree of contraction of the clot, the intensity of the inflammatory action is commonly inferred. Whenever the coagulum is dense and firmly contracted, and more particularly when it is rounded like a cup and floating in the serum, with a tough layer of size occupying the upper surface, the indication of the most acute inflammation is generally supposed to be announced, and reiterated blood-letting to be demanded.

The contrary state, when the coagulum is loose and flabby, does not separate from the serum, and is destitute of a sizy coat; or should one exist, being of a soft gelatinous consistency, and having a greenish hue, is regarded as indicative of an inflammatory grade that will not bear general depletion, or the system tolerate the lancet.

The appearances of the blood in the first instance, is generally attendant on the acute inflammations of organs highly vascular, as the lungs and liver, or of serous and fibrous tissues, in the irritations of which, the general sanguine system freely partakes. This state of the blood is seldom seen in the acute inflammations of the mucous tissues, in which the characters of the opposite states more frequently prevails, particularly when very extensive.

The concrescibility of the blood augments in particular cases, to a point that may be regarded as morbid. In this state concretions not unfrequently form during life, more particularly in the cavities of the heart; and in the left with more frequency than in the right cavities. These concretions were long mistaken for polypi, but possess no analogy with them. They consist of the fibrinous and albuminous principles of the blood, free from the colouring matter, and are of dense, firm consistence, when they have been formed some time previous to dissolution; they are softer and less consistent when their formation is more recent. They are not to be confounded with the coagulated blood commonly found in the heart after death. In colour they vary from a yellowish to a very clear white.

These concretions, when they form in the heart, oppose a serious obstacle to its natural actions, and constitute one of the causes of a fatal derangement of its functions. The following is

a case in which a concretion of this kind had existed for a considerable period. A man entered the clinical medical ward of the Alms-house Infirmary, in the winter of 1825. He had long complained of shortness of breath and incapacity for exertion, and was supposed to labour under hydrothorax. There was no cellular infiltration or emaciation; he was excessively distressed in his breathing at the time of his admission. On examination I found healthy resonance of the chest; and the stethoscope made known a natural though very faint respiratory murmur in both lungs. The action of the heart was feeble, very indistinct and irregular. Not being able to determine the exact nature of the affection, I directed him to be placed in bed and have a regulated diet. The next day, the difficult respiration brought on by the exertion of entering the house and ascending the stairway had disappeared, and he felt quite comfortable. No treatment was instituted, and he remained several weeks in the ward without manifesting any particular symptoms. From some cause, most probably an indiscretion as to diet, his stomach and bowels became disordered in the night; great distress of breathing ensued, and he expired suddenly before morning. The body was examined next day. No effusion existed in the pleuræ or evidences of disease in them. The lungs were crepitating and perfectly natural. The right ventricle of the heart was dilated. On opening it, a solid, pearl-white concretion occupied nearly half its cavity; it adhered very firmly to the sides of the ventricle, and extended into the pulmonary artery and its first ramifications. It approached in consistency to cartilage. I presented the specimen to Dr. Horner, and it was his opinion and that of Dr. Physick, who saw it at the University, that it must have existed in the heart for a considerable period before death.

The experiments performed by Professor Mayer,* to determine the cause of death from the division of the par vagum, or pneumogastric, appear to render it probable, that these fibrinous concretions proceed from a diminution or suspension of innervation, which is necessary to maintain the fluidity of the blood.

A condition of the sanguine fluid, the reverse of the preceding, prevails in some states of disease. Its plasticity is enfeebled or

* Journal des Progrès, Tome iii.

destroyed, and its colouring matter escapes from numerous surfaces and organs. This state of the blood is common in the worst forms of fever of typhoid, ataxic or malignant character; in yellow and malignant bilious fever, &c.: it gives rise to the hæmorrhagic effusions, that so often manifest themselves in those forms of fever from the internal tegumentary, or mucous membranes; from the secretory organs and sometimes the skin. The blood is mostly found to be fluid after death, and is said to be in a dissolved or putrid state. The correctness of this observation is doubtful. In the examinations of those who died of yellow fever in 1820, the blood was found uniformly fluid, and on the faith of former observers was, at first, set down as dissolved or putrid, but when it was placed in small cups, it coagulated in a few minutes. I have never met with blood, even in the worst forms of typhoid fevers, that possessed putrescent characters, or that did not coagulate.

In the humoral pathology, putridity of the blood was supposed to be a common occurrence, and was the immediate cause of the phenomena of putrid fevers. This opinion shared the general fate of the humoral doctrines. It has again been revived within a few years. Some coarse experiments have been performed by Gaspard, Majendie and Bouillaud,* in the view of sustaining this fact. They consisted in the injection of putrid liquids, putrid urine mixed with water, &c. into the veins. From this proceeding was generated fevers presenting the characters of putrid fevers, and in most of the experiments terminated fatally. In every instance inflammations of the most aggravated character ensued, especially in the gastro-intestinal mucous membrane, in the heart and vessels, and, in fact, in most of the organs, eventuating in intense congestions, in ulcerations, in gangrene, &c. These experiments cannot be regarded as conclusive in proving a putrescent state of the blood. They establish these points, that irritating matters injected into the vessels will produce inflammation of excessive violence; and that extended inflammations, involving the organs whose functions perform an important part in the maintenance of vital phenomena, will occasion the symptoms of what are called putrid fevers.

* Journal de Physiologie, Tome ii. et iv. Traité Clinique et Experimentale des Fièvres, &c. par J. Bouillaud.

That putridity does actually occur in the blood during life, is a most questionable circumstance, and has not yet been demonstrated.

That the crassis or constitution of the blood may be affected, by the loss of function in organs requisite for its healthy formation, is not improbable, and may possibly be an effect in the diseases called putrid fevers; but in what that effect consists has not been detected.

§ 3. *Humours of Third Class.*

The fluids or humours of the third class, or of the secretions, are variously modified by disease, especially by inflammation of their organs, the phenomena of which are the most common and appreciable.

The fluids exhaled from the serous tissues, as has already been shown, in a natural state, is a limpid serosity, having nearly all the properties of the serum of the blood. In the inflammation of this tissue the serous exhalation experiences different modifications, becoming with the progressive increase of the inflammation more viscid, containing coagulable matter, impregnated with albumen and fibrin, which, in an intense degree augments so much as to form a plastic layer or pseudo-membrane on the serous surface, accompanied with globules or molecules, similar in every respect to those of pus. These last, at times, are in such quantity, that the effused fluid possesses all the properties and character of genuine pus. When the inflammation of the serous tissues runs into an extreme violence, the exhaled fluid is often highly sanguineous. In a lady who died in this city in 1820, of peritoneal inflammation, a black flocculent fluid resembling the black vomit of the yellow fever, was found in the abdominal cavity.

The fluid of the synovial membranes, which differs from the fluid of the serous membranes, by containing a portion of albumen combined with fibrin, assumes with great facility the purulent character. From the slightest inflammation of these membranes, pus will be formed in the articulations, even when the marks of synovial inflammation are scarcely to be discerned. In gout the puriform fluid exhaled into the articulations, contains an excess of carbonate and phosphate, and sometimes urate of lime, whence are produced the tophi so often found in the joints of those who have experienced repeated gouty attacks.

The external tegumentary or dermoid tissue, exhibits various changes in the fluids it secretes, when it is the seat of inflammation. When of a light shade, a serous fluid, not unlike the serum of the blood, but with a larger quantity of coagulable matter, is poured out, as occurs in vesication.

The coagulable matter increases with the inflammation, and consists of albumen and fibrin, which become gelatinous. Finally, purulent globules or molecules appear, which augment until the inflammatory product is entirely purulent. In the chronic inflammation of the skin, besides the secretion of pus, is to be observed also that of an albuminous coagulable fluid, and vitiated sebaceous secretions, producing concrescible fluids, mixed with the different saline matters found in animal products, and of these different chemical combinations are formed the scabs, squamæ, crusts, &c. that assume so many various aspects in the chronic diseases of the skin.

From the internal tegumentary or mucous tissue, mucus is secreted and serosity is exhaled, in a healthy state of action. These products are augmented under the influence of irritation and inflammation, both acute or chronic. From the same causes they undergo a change in nature and character. Inflammation of this tissue occasions discharges of fluids, that are either mucus, sero-mucus, or mucoso-puriform.

The first or mucous secretions, occur in the feebler states of irritation of the mucous tissues, and varies somewhat in each. It is viscous and of a yellowish-white from the conjunctiva; liquid, demi-aqueous and whitish in coryza. In acute bronchitis it is at first diaphanous, ropy, like a solution of albumen in water, and adheres to the vessel in which it is contained. From the gastric mucous membrane in gastric irritations, it is liquid and contains clots floating in it of greater or less thickness. In the acuter forms of inflammation it is more viscid and even plastic; after death it adheres with tenacity to the mucous coat of the stomach, and is coloured often with bile. The mucous discharged from the bowels in diarrhœa is of a pale yellow, and has few flocculi. When it proceeds from the inflamed vagina or urethra, it is liquid, sometimes diaphanous and mostly whitish. That which is secreted by the bladder, is united to the urine in viscous flocculi, but which separate immediately and settle at the bottom of the

vessels. On the contrary, when it proceeds from the ureters and pelvis of the kidneys, it is dissolved in the urine and floats in the centre of the liquid mass, like a cloud of a grayish-white colour. This appearance is what is meant by the eneorema of Hippocrates.

The mucus secreted during the increase of active inflammation, is said to be of alkaline properties, from the presence of soda, and turns vegetable blues green, except that from the digestive tube, which contains an acid. This acid Leuret and Lassaigne assert to be the lactic, but it would appear from Tidemann and Gmelin's experiments to be the muriatic. It is from the presence of this acid, that the colouring matter of the bile is converted into a light grass-green, which is seen in vomiting at times, and in the dejections of children.

The sero-mucous excretions of the mucous tissues are more liquid than the preceding. They are sometimes completely aqueous, as is seen in some diarrhœas, and I have met with instances of it in bronchitis. It is sometimes in bronchial inflammation streaked with blood, and contains coagulated white clots that may be taken for tuberculous matter. The sero-mucous fluid in acute inflammations, is often very acrid, as is proved by excoriation of the lips and cheeks in coryza, and some ophthalmias; the borders of the anus in dysentery, and the superior and internal part of the thighs in leucorrhœa.

The mucoso-puriform fluid is the more common product of the phlegmasia of mucous membranes. It forms profusely on the conjunctiva in purulent ophthalmia, and is then yellow, ropy, viscid and very slightly acrid. In coryza it makes its appearance as the inflammation declines. It succeeds also, to the sero-mucous secretion in bronchial irritations: it generally indicates the diminution of the inflammation. In diarrhœas, when it proceeds from the mucous tissue of the colon, the stools appear to be composed of pure pus. In the diarrhœa of fevers it is mixed with serous discharges, and sinks to the bottom of the vessel in a powdery form, resembling oat-meal. This is always, I believe, a fatal symptom. Gonorrhœa or blenorrhagia offers the mucoso-puriform fluid of a greenish-yellow colour. This secretion occurs also in cystitis and nephritis. In the first it precipitates from the urine immediately, and forms a layer viscid and somewhat dense, which the

urine does not appear to penetrate. But in the last the deposit does not separate for two or three hours, and is then loose, having its constituent flocculi penetrated and separated by the urine.

The mucous and sero-mucous secretions, may continue after all traces of phlogosis, which originally excited them have disappeared, and are not an evidence of the existence of chronic inflammations. This is not the case with the mucoso-puriform fluid, which is always the product of either acute or chronic inflammation. In the last case, the puriform matter is unequally mixed, or separated in flocculi from the liquid mucus.

The mucoso-puriform fluid in some cases of chronic inflammations of mucous tissues, acquires a character entirely purulent, and is then often supposed to be the result of ulcerations. It is not unfrequent from the nasal fossæ; it takes place occasionally from the bronchial surface and sometimes from the bowels, forming purulent diarrhœas, that are rapidly colliquative, and in which, on examination, inflammation of intestinal mucous tissue is discovered, but without ulcerations.

The morbid changes induced by disease in the glandular secretions, are much more imperfectly known than those already examined.

The saliva when the salivary glands are excited by the mercurial irritation, is augmented in quantity, becomes more viscid and ropy from the presence of albumen, and occasionally possesses a sanguineous tinge. In animals affected with rabies, it acquires poisonous properties, producing in those into whose system it is introduced, the same disease. Whether the same change in this secretion, is a result of the disease in a human subject, I believe has not been made the subject of experiment. Of the modifications that may be induced in the salivary secretion of the pancreas, not the slightest information exists.

Our knowledge of the morbid condition of the biliary secretion, though this fluid is so much talked of in accounting for pathological phenomena, is exceedingly imperfect. Irritations developed in the liver often increase its secretions, as is manifested by copious bilious dejections and vomitings. On the other hand, it is frequently seen to be diminished in intense irritations and inflammations, as in cholera morbus; and the same state is the consequence of chronic irritation of the biliary apparatus.

The constitution of this secretion, the most complex of the animal fluids, is affected most probably by inflammation of the liver, but what the particular effects induced are, it is not easy to determine. Most commonly the dark and black stools that occur in fevers are attributed to vitiated bile. No proof, however, has been adduced to render the supposition certain, and it is much more than probable, that in most cases, the discharge is a vitiated secretion of the mucous surface of the intestines. This is seen to occur in yellow fever, when the colouring matter of the blood, somewhat modified, is effused into the alimentary canal, from the surface of the stomach and intestines.

In the autopsies of fatal cases of fevers, the discoloured contents of the alimentary canal are frequently found to occupy the lower portion of the ileum and colon, while the contents of the jejunum are nearly natural; and alternate portions of the intestines are repeatedly seen to contain dark and discoloured matter or healthy mucus; the unnatural secretion corresponding with diseased portions of the mucous tissue from which it has proceeded, and not from the liver.

The green hue which the alvine discharges often present, especially in children, does not arise from any circumstance connected with the secretion of bile, but results from a free acid acting on the colouring matter of the bile in the alimentary canal.

Under particular circumstances, the cholesterine, one of the principles of the bile, separates in the gall-bladder, and forms the biliary calculi found in that viscus. In a fatal case of dysentery, I found the gall-bladder distended, with a pellucid mucus, from which the colouring matter had separated, and subsided on standing, in loose flocculi.

The bile in the gall-bladder is sometimes very thick, and apparently of an intense black, but if it be spread on a white surface, it will be found of a deep green. It is this that is commonly supposed to be black bile; I much question whether black bile is met with.

The urinary secretion is extensively modified by diseased action of its secretory organs. In a general manner it may be laid down, that an inflammatory action of the kidneys and an acute sanguine irritation of the system, are accompanied with an acidifying process; that the natural acids and saline principles of the

urine are augmented in quantity, and often new acids, as the purpuric, or rosacic acid, and new saline principles are developed. These principles are so abundant, especially the uric or lithic acid, which is very insoluble, that they assume the concrete form, whence is produced gravel and calculus. The urine in this state is scanty and highly coloured. On the contrary, a feeble action of the kidneys, or nervous irritation, is accompanied with a deficiency of the acid principles and a predominancy of the alkaline, and earthy matters of the urine; or albumen is contained in it in quantities, at times so considerable, as to render it coagulable by heat and acids. The urine is then copious and of a light colour.

In the most intense states of gastro-enteritic inflammations, the urine ceases to be secreted, and is a fatal symptom.

From the appearances offered by the precipitates, and the principles that are to be detected in this secretion, in disease, inferences of great value may be deduced, in establishing the pathology of disease, and in determining a prognosis.

In the preceding pages we have examined in a rapid and often cursory manner, the animal mechanism. It has been shown to consist of solids and fluids acting conjointly, and which are composed of similar elements, the remote animal elements, gelatin, albumen and fibrin. These assume two forms, globules and a coagulating amorphous matter, which are disposed in a fibrous or laminary structure.

The solids themselves consist of, 1st. Remote organic elements, or the fibrous and a laminary structure; and 2d. Of proximate organic elements or tissues. Of these are composed the organs of the economy, which have particular acts or offices to perform, named functions; the functions differ in each organ, and result from actions that are termed functional actions : they are not all immediately essential to life, and may be changed or suspended without necessarily occasioning death.

Besides the functional actions particular to each organ, there exists actions or movements in the solids common to them all, of the same nature in all, varying only in degree or intensity. These actions are molecular and nutritive, or formative; they are inherent in organized structure, and are positive and vital in their character. Their alteration from a normal type is the immediate

cause of pathological phenomena; causes derangement of function, constitutes the essential nature of disease: their suspension in the more perfect animal organization, inevitably entails a fatal result. These actions are the organic, or vital actions of the organism; and proceed from forces or properties that are innate to organized structure. These properties or forces are vital, and require to be examined, analyzed, and their general facts determined.

CHAPTER III.

Vital Properties or Forces, and Organic Actions.

The organism or animal system, composed of organic solids and organic fluids, or animal tissues and organs, is susceptible of modes of action from which result a peculiar class of phenomena, that are termed vital. Life, as Richerand defines it, is the organism in action.

The ultimate term of the relations of animated beings, physical or intellectual, with the exterior world by which they are surrounded, is an action. The actions of living beings are not self-existing, or have a positive independence: they are effects. They depend on two circumstances or causes for their production. First, organized matter, organs endowed with a force or aptitude to experience the impression of exterior agents or influences; 2d. The actual impression of these exterior agents or influences.

Without organized matter and organs, there can be no manifestation of vitality; there can exist no vital phenomena. Without exterior influences, organized matter and the organs, remain quiescent; they possess no positive activity; they cannot enter into action; no vital phenomena can be called into existence. The absence of either is fatal to vital activity; vital actions cease when either is withdrawn; they cannot commence or continue without the concurrent aid of both.

Sect. I.—*Of Organic Force, or Irritability.*

The power inherent in organized matter, which disposes it to be acted on by stimuli, may be termed organic force. Its nature is unknown; we are unacquainted with the manner of its development; it can be appreciated only by its effects.

This force is first acquired by a germ in the act of fecundation, which is the object or end of the process of generation. When once acquired and the appropriate stimuli are present, it cannot remain quiescent; its activity is called into exertion; vital actions commence and vital phenomena are manifested.

Vital actions once commenced, in the higher order of animals, cannot be again suspended for any length of time; they have different degrees of energy, but, if once terminated or reduced to a certain point, they are not again renewed; their cessation is permanent, and with them ceases the organic forces. This constitutes death.

In the inferior animals and vegetables, the vital actions are capable of suspension without their destruction, the organic force diminishes, but is not entirely extinguished. On the renewal of stimuli, the vital phenomena again reappear and the organic force is renewed. These facts are seen in hybernating animals, and in vegetables in the temperate latitudes, having alternate seasons of opposite temperature. The abstraction of the stimulus of heat diminishes the vital actions, the functions of the various organs essential to life are gradually suspended, and almost every trace and sign of animation are lost. With the renewal of the stimulation of caloric, whether artificial or solar, reanimation commences, the vital actions are reawakened, they are manifested in the fullest energy; and the organic force which had been nearly extinguished, acquires its former intensity.

Cold-blooded animals, as frogs, have exhibited remarkable instances of the suspension of vital actions and a latent state, as it were of the organic force, that has endured for a very protracted period.

In the higher order of animals, the fecundated germ is surrounded by the external influences requisite to call into activity

its organic force and procure its development. Its actions, in consequence, immediately commence, and are unceasingly maintained during its existence.

In plants, the oviparous and the lower order of animals, the disposition or aptitude to action, the organic force, though acquired, may exist in a quiescent or latent state, until the appropriate excitants, heat, moisture, air, are brought to exercise their energies upon it, when the active phenomena of their life commence.

Every organized or living being is developed after a certain type. This is accomplished by the acquirement and appropriation of exterior and dead matter to its own substance, and is the first result of the action arising from the impression of stimuli on organized matter, or possessing organic force.

The organic action is essentially nutritive and formative. In this process inorganized matter becomes organized; that which was dead is quickened. The susceptibility to exterior influences or the organic force, must of necessity be acquired in the nutritive or organic action. The organic force consequently must be derived either from a primitive stock imparted to the germ, adequate to all the demands that may be made on it during the existence of the individual, or is acquired by matter in the act of becoming organized. The first is not probable. The germ does not possess the organs of the fœtus; or the fœtus those of the adult. How vast is the disproportion between the incipient germ, and lordly man, the ponderous elephant, the unwieldy leviathan of the deep, and the gigantic oak, the monarch of the forest, which proceed from it. Can it be supposed that the organic force, which imparts to organs their capacity for action, exists before the organs are formed; or that in the punctum saliens is included the power that is destined to bestow the active energies, and maintain the phenomena of the immense mass of matter, that composes its perfected and developed type? These are suppositions that would be wholly gratuitous, without fact or analogy in their support.

However organized or produced, the susceptibility to external agents, or the organic force, is an ultimate fact of organization too conspicuous to be questioned. It belongs to all organized matter whatever its form, state or condition. It is inseparable from or-

ganization, and is the first element, an essentiality in every act or phenomena of life. It is then a vital property, possessed by every organized being, enjoyed by every portion of the living animal and vegetable structure.

Organic matter it has been shown, is not a unit. It consists of remote elements differing in nature and existing in different forms and states; and it has likewise been demonstrated, that in every organized structure, it is formed of proximate elements of different composition, each manifesting peculiar phenomena and possessing particular functions. The susceptibility to the influence of exterior agents, inseparably connected with organization, does not manifest the same phenomena or species of action, in each of the remote organic elements, or in each of the proximate elements or tissues of which organized bodies are composed. The phenomena resulting from this property of organized matter vary in each of its forms. The property, however, is the same in all; in gelatin as in fibrin, in fibrin as in albumen; the same in mucous tissue, in serous tissue, in muscular tissue, in vascular tissue, in nervous tissue; the same in gland, in membrane, in bone, in nerve, in ligament. The differences that are observed in the phenomena of organized matter, proceed from the differences in the nature, in the essential properties or qualities of the organic elements. The vital property or susceptibility to action is the same in every form, though the phenomena are diversified. This is analogous to what is observed to prevail throughout nature, in inorganic matter and the phenomena it displays.

A single principle, affinity, modified by a few circumstances, operating on the various kinds of matter, occasions all the varied phenomena, in the forms, the actions and the characters of the innumerable objects of the universe. Gravity in like manner, acting under different modifying causes, and influenced by the innate qualities of different substances, is the only source of all the variety of motion, or the sensible movements of physical objects. It is the cause maintaining the planets in their rapid and eternal course, whence proceeds the swift descent of ponderous bodies loosened from their seats, and the slow subsidence of fleecy down in the air, or of minutely divided feculence in fluids.

All the active forces of nature offer to investigation the same

results. A single principle acting under different circumstances, and exerted on substances of different natures, is sufficient to produce innumerable effects, and to explain phenomena the most varied.

From a priori reasoning it might be inferred, that organized matter would exhibit the same general result of a principle or law, operating to the production of numerous phenomena. Examination into the phenomena of organized matter demonstrates the truth of the proposition. A single principle, as has been shown, the organic force, by the reaction provoked by the impressions of exterior agents, is the active principle of all vital phenomena. The remote and proximate elements of animal and vegetable organs or structure, are of different nature, and hence the manifestation of the action of the organic force, is different in each according to their respective natures, and their innate properties. In this manner, organized matter, by the operative power of a single principle, modified by the nature of the remote and the proximate animal elements and the functions of organs, is capable of giving origin to all the phenomena of physiological and pathological life.

It is of the first importance in determining physiological and pathological questions, to possess fixed and positive ideas in respect to this vital property. It has been designated by various appellations, as irritability, excitability, contractility, motility, &c.

It happens, however, to be unfortunately the case, that these terms are understood in different senses by those who endeavour to fix their meaning; and still more unfortunate that very few attach an absolute idea to these terms, while they refer to them as ultimate and explanatory principles, in reasoning for the solution of difficulties, the explanation of facts, and the establishment of principles.

To avoid the confusion that arises from the collision of writers in their views as to this principle, and the ambiguous meaning in which these phrases are employed, it will be proper to present a summary of the principal doctrines that are held on the vital properties, and the different meanings in which the term irritability, &c. are commonly employed.

The term irritability was first introduced into medicine by Francis Glisson. This truly eminent philosopher, the precursor of Leibnitz, rejected the dogma of the schools, sustained by the authority of Descartes, that matter is inert. Applying his general ideas to the phenomena of life, he established as a principle, that all the organs of the human body possess an inherent and especial force, presiding over their movements, and essential to the performance of their functions. To this force he applied the term irritability, because it enters into action from external and internal irritations. This property he divided into three species; natural, as affected by direct irritation; sensitive, as acted on by impressions on the senses; and cerebral, (à phantasia,) as originating in the brain. He believed, also, it was modified by the constitution, and existed in different grades. When moderate, health was the effect; when too acute or in excess, or when slow or deficient, disease was the result.

The ideas of Glisson were too much in advance of the knowledge of the age, to meet with a favourable reception, and to gain proselytes. Upwards of half a century subsequent to their promulgation, they were adopted by De Gorter, who improved upon them, and gave them a greater extension. Irritability, he considered a property of all organized matter, vegetable as well as animal, and all the actions of living beings, he regarded as depending on and directed by it. Thus, he admitted but a single vital property in the different parts of living bodies, whose variable characters or phenomena, resulted from the differences of the structure of the organs.

The ideas of Glisson and De Gorter, which were in the spirit of a sound philosophy, gradually insinuated themselves into medicine. The cause of life was no longer explained by the mixture of the constituent elements of organized bodies, hypothetically admitted; or by the principles of a mechanical construction. An inherent force in organized matter, was recognised. But departing from the ideas of Glisson and De Gorter and the principles of severe reasoning, this force became personified, and an existence was supposed for it as a vital principle, independent of matter and organization.

This relapse into the obscure doctrines of occult and final causes, was arrested by the genius of Haller. Gifted with a

clear and powerful intellect, master of the knowledge of his time, devoted to observation and enquiry, and persevering and fruitful in experiment, Haller was destined to be the restorer of physiology, and to lay permanently its foundation on the only substantial basis of the phenomena of the animal economy, well observed and faithfully reported. Recognising as the result of his enquiries and observations, inherent forces in organized matter, he formed a system of what has been called the vital forces or properties.

Haller adopted very nearly the ideas of Glisson. He distinguished, however, sensibility from irritability, which the other had confounded. Regarding sensible contractions as the test of irritability, Haller confined that property solely to the muscular fibre.

Haller, by making contraction on the application of an irritant the test of irritability, was led into the adoption of erroneous principles and conclusions. His irritability is the manifestation of that property in fibrin and muscular tissue. The want of contraction when an irritant is applied to a living tissue, proves that fibrin and muscular tissue are absent, but does not establish the want of organic force or irritability.

Haller in distinguishing sensibility from irritability, made the first a vital power. By sensibility, impressions on the body are communicated to, and perceived by, the intelligence, and thus we possess sensations. But for the production of this phenomenon, a set of organs, a particular apparatus, have been provided. Sensibility is, then, a function, the office of a particular apparatus of nervous organs, and not a vital property. Vital actions may exist and vital phenomena be manifested, without sensibility. It ceases before the death of the body has taken place.

Haller made a third vital power, common to all the animal fibres, which he called dead power, (vis mortua.) It gives tone or force to the soft parts, without manifesting contractions on the application of stimulants, and does not abandon them until complete disorganization has ensued.

This last property Haller considers as distinct from irritability, merely because contractions, in certain tissues, are not excited by chemical and mechanical irritants. But as sensible contractions from common irritants are limited to muscular fibre, this circum-

stance is not to be considered as an evidence against the possession of the vital property, irritability, in tissues that have no fibrin or muscular fibres. He was, therefore, in an error in creating this third vital property as distinct from irritability. It is identical with the irritability of muscles, though modified in its manifestation by difference of structure; and in some tissues is but slightly apparent from existing in a feeble degree.

Haller confounds two things totally different in his third vital property or vis mortua. The one is irritability as manifested in cellular, fibrous, cartilaginous tissue, and in which it exists in a low degree. The other is the organic or vital affinity, the immediate agent of nutrition, which preserves the composition of the animal structure, and resists the influence of the powers of common chemistry that tend to its destruction. It is the vis insitum of Glisson.

Placing sensibility among the functions where it belongs, and dispossessing it of the title of a vital property to which it has no claim, we find that the three vital properties of Haller are reduced to a single one, which is the irritability of Glisson and De Gorten, or, as it may more properly be named, organic force.

The doctrines of Glisson and Haller, were warmly opposed by the animists or followers of Stahl, the most distinguished of whom was Whytt.

By this school every vital action or phenomenon was supposed to be the immediate result of a separate independent principle or soul.

The difficulty of accounting for the continued susceptibility of the heart, intestines and muscles to the impression of irritants, for a considerable time after being torn from the body, compelled Whytt to admit an extended and divisible soul, occupying all the portions of the structure. He thus made the soul a material substance in opposition to his own principles; and destroyed the very ground-work of his objections to the doctrine of the inherent irritability of the organization, on which vital actions are supposed to depend.

The doctrine of irritability had many able advocates, besides the Swiss physiologist. Of these, the most distinguished were De Gorter and Winter, his cotemporaries, and Lups, a disciple of Winter.

14

Haller, by making sensible contraction, or the shortening of a part, by external contact, the test of irritability, had reduced it to limits so narrow, that it was insufficient to explain the general phenomena of the vital movements. With this limitation, it is no more than the property of a muscular fibre, whose contractions it serves to explain; but it is not applicable to the solution of other vital movements.

De Gorter, as has been stated, had embraced the views of Glisson, and developed with more accuracy the effect of irritants on vital motions, and the laws of excitement. He avoided the error of Haller, by extending irritability to all parts of the body.

The same doctrine was inculcated by Winter at Frankener, and afterwards at Leyden; and his pupil Lups, elucidated its existence in the inferior animals, as polypi and in plants.

The principles of these writers, may be considered as having laid the basis of the doctrines of irritability and inflammation, that have been adopted by a large class of physiologists of the present day, and which prevail in what has been called the physiological doctrine of medicine.

Another doctrine which may be called the nervous or neurological doctrine of irritability, is advocated by a large class of physiologists. Its foundation is laid in the theories of Stahl and Hoffman, of which it is a modification.

Stahl had supposed an anima or soul to reside in the brain, whence it governed, as well as produced, all the actions of life; and Hoffman approaching to this idea, conceived the cause of vital actions to consist in the influence of a sensitive soul, a species of ether, spread throughout nature, but separated from the blood by the brain, in animals. The soul or vital principle, on this hypothesis, was a secretion.

Cullen and Gregory of Edinburgh, and Macbride of Dublin, modifying these opinions, established the modern neurological doctrine of irritability. According to this doctrine, vital phenomena are dependant on the brain and nervous system. No susceptibility to action is admitted as inherent in the fibre, or any tissue, independent of the nervous system; and, consequently, irritability is a nervous property, communicated by the nerves and emanating from the brain. In this view irritability would be, as we have seen from the definition given, a function, like

sensibility. But the brain and nerves are themselves endowed with irritability: from whence then can they derive that which is peculiar to themselves, unless it be a vital property and not an effect of a function.

This view of irritability appeared a few years past, for a time, to be sustained by the experiments of Le Gallois.

When repeated, however, by Wilson Philip, a source of error in the experiments of the French physiologist was detected, that rendered all his conclusions fallacious; while the Glissonian and Hallerian doctrines of the inherent nature of irritability in the fibre, was most fully confirmed. Besides, irritability is a well known property of vegetables and the lower animals, in which no nervous structure has been demonstrated to exist, and of course must have an existence independent of nervous structure.

Bichat, influenced by his doctrine of animal and organic life, divided irritability into several vital forces. The irritability of Haller, or, as it is exhibited in the muscular tissue, by contraction, he divided into animal and sensible organic contractility; and, as it is displayed in the other tissues of the animal organization, and in vegetables, he named it organic sensibility, and insensible organic contractility. No advantage can arise from this mode of dividing irritability; and it leads to confusion and perplexity, by considering a single property, modified by organization, as several distinct properties.

The term contractility, employed by Bichat, has been very generally adopted by the French physiologists, and substituted for that of irritability. It is objectionable, as founded on a single phenomenon of irritability; and, as displayed chiefly in a particular kind of structure. We are not authorized to infer, from this circumstance, that irritability in action, in other tissues and structures, is always attended with contraction. There are appearances that would justify an opposite conclusion; and from which Prus has been led to propose expansibility, as a vital property.

Modifications of the preceding doctrines have been made by various writers, but the different theories of irritability, may be all referred to the three mentioned; and which it may conduce to clearness and the better understanding of this subject to present in a condensed summary.

1. The Glissonian; as modified by De Gorter, Winter, &c.

According to this doctrine, irritability is a property inherent in all organized matter, whether animal or vegetable; and, by which organized structure possesses the faculty of entering into action, from the impression of external and internal stimuli.

2. The Hallerian; which makes irritability an inherent property, (vis insita,) of the muscular fibre, to which it solely belongs, and of which contraction is a test. In this restricted sense, it is not received by any physiologists of the present period: though many, adopting the erroneous test of Haller, are led to deny the existence of irritability, where contractility is not manifested.

3. The neurological; by which irritability is taught to be a nervous property, derived from the brain, and communicated to the different parts of the body, by the nerves. This doctrine is maintained by many of the English, French, and German physiologists.

The first doctrine is the one most generally received, and appears to be the most in consonance with the general facts of irritability, observed in animal and vegetable organization.

Lamarck contests the existence of irritability in vegetables. He denies irritability to this class, from the absence of sensible and sudden contractions and motions, capable of repetition; that is, of the phenomena of irritability, as exhibited in animal fibrin. He was evidently led into this error by adopting the test of Haller, contraction, as the certain index of the presence of irritability, and its absence as the sure indication of the deficiency or absence of that principle. But plants are in possession of a circulation, conducted by a system of delicate capillary vessels; they have the functions of nutrition and they perform numerous secretory processes; they are subject to diseases; they experience the stimulant action of heat, and sedative operation of cold; all which imply, unequivocally, the existence of irritability, as an inherent property.

The term excitability, as employed by Brown, expresses a meaning somewhat different from irritability. It includes, in the acceptation he gives to it, sensibility, as well as irritability.

Sensibility is but a partial faculty; it has a peculiar set of organs for its exercise; it is, therefore, a function. The term sensibility should be reserved to designate this function of the ner-

vous system, and in every disquisition on this subject, it should be so regarded, and not confounded with irritability, or that property inherent in every organized tissue or fibre, by which it becomes susceptible to the action of stimuli.

The term excitability may be used with advantage, as a synonyme for irritability. This property being the base of every vital action, it must exist in different states or degrees, in the different conditions of health or disease, or of its normal and anormal existence. The employment of the same terms in speaking of the different states of this principle, of the agents that influence it, and to express the different actions the two maintain or produce has many inconveniences, and leads to misconception. Hence excitability might very properly be adopted to designate the normal or healthy degree of irritability; its physiological condition. Excitants and excitation, or excitement, would then be correspondent expressions of a similar character, confined to express the natural or physiological state. Irritability, irritants, and irritation, would be employed only in a pathological sense, when treating of the anormal or diseased phenomena, to which they would respectively apply.

The preceding exposition exhibits the recognition of a principle, in all the received doctrines, to which is ascribed the property of responding to the impression of stimuli, irritants, or exterior agents, and which is the characteristic of organized or vital structure and animated beings. This principle, it is conceived, has been shown not to be a function derived from the nervous system, as is supposed by some, but is inherent as a vital property in all organized matter, animal or vegetable, and whether nervous structure is present or not.

This force, which we have called organic, and which is the same as the irritability of Glisson, is the basis of every organic or vital action. It is consequently the most essential principle in studying the pathological condition. In studying this condition which may be regarded in the light of a problem, two elements present themselves to be settled by the practitioner of medicine. The first is the organs or tissues in a state of lesion, or which have departed from their natural state; and the second, the condition, and intensity of the organic actions, that are the measure of the state of the organic force or irritability.

This is the only certain basis for the establishment of a sound diagnosis, and on which the treatment of diseases can be rationally instituted.

The following are the generality of facts or laws of the organic force or irritability, deduced from an attentive examination of the phenomena of which it is productive.

First law.—Irritability, is a common property of all organized matter, and, is a first result of the vital chemistry or affinity, by which matter is brought into, and maintained in an organized state. It is a property of the solids alone.

Second law.—Irritability, though a common property of organized matter, yet being a result of organization, is modified by every difference of organization. Thus the irritability of a plant differs, in some respects, from that of an animal; that of the inferior animals, differs from that of the superior; it even varies in the several genera of plants and animals; and is not precisely similar in the different tissues and organs of the same animal. Some flourish, under circumstances in which others perish. Substances that are destructive to some, are innocuous to others, or serve to their nutrition. This law enters, also, into the explanation of many physiological facts of the temperaments and idiosyncrasies of individuals.

Irritability, we have said, is modified in the different tissues and organs; and even in different portions of the same tissue. Hence proceeds the diversified effects of different substances on the economy. Purgatives do not affect the mucous membrane of the stomach, in its healthy state, as they pass through it, but provoke a violent irritation of the mucous membrane of the intestines. When emetics, as tartarized antimony or emetin, are injected into the veins, or into the cellular membrane of the thigh, they affect, notwithstanding the mucous membrane of the stomach, precisely the same, as though applied directly to that organ; and after death, if used in quantities sufficient to destroy the animal, the appearances are the same as result from their actual presence. Cantharides employed as vesicatories, occasion irritation at the neck of the bladder. Strychnine and brucine, act only on the spinal marrow, exciting tetanic convulsions, with perfect integrity of the cerebrum and intellectual faculties. Opium, on the contrary, affects the medulla oblongata and cere-

brum, and has no direct action on the spinal marrow. Hydrocyanic acid expends its deleterious force on the respiratory portion of the medulla oblongata and spinalis, occasioning instant death. Secale cornutum excites the contractile power of the uterus, but of no other part.

The poisons offer additional exemplifications of this principle. Mr. Brodie has shown, that the infusion of tobacco thrown into the intestines, destroys life by annihilating the irritability, and consequently arresting the action of the heart. The essential oil of almonds, and juice of aconite, are fatal by their action on the brain and spine, while the heart continues to pulsate in nearly its natural manner during the stupor, convulsions and laborious respirations they induce; and continues its actions, even some minutes after death. Woorara, a species of ticunas, kills also by its destructive excitement of the brain; while the poison of the upas antiar—antiar toxicaria of Leschenaut, produces its fatal operation, by destroying, like tobacco and aconite, the action of the heart. The poisons of the viper, of the rattlesnake, of the cerastes or horned snake, are likewise innocuous when taken into the stomach, inserted into the body of a nerve, in tendon or cartilage, but speedily display their deleterious influence when applied to a denuded vascular surface, or inserted into a vascular structure, as muscle, skin, &c. These different effects of the same substance on different tissues, can be understood in no other manner, than as the consequence of a difference in the irritability of the different organs and tissues.

Third law.—Irritability has its source in the system. It is constantly fluctuating, being greater or less in degree, either in the whole organism or in certain organs. It is dependant for its production on the activity of nutrition, the quantity and state of the fluids, and the facility of their circulation.

Brown supposed "a certain quantity or certain energy of excitability to be assigned to every being upon the commencement of its living state." This conjecture is wholly unsupported. It is impossible that the embryo should possess the full quantum of excitability, requisite for the adult; or the acorn for the full grown oak. Neither is it possible that irritability can exist for organs that are not formed.

Fourth law.—The quantity of the fluids influences the produc-

tion of irritability. It is always most active in the most vascular structures, and it never increases in a part without a corresponding increase of fluids in that part. Whenever the irritability is diminished, the fluids are uniformly in less quantity, wherever that diminution has occurred; and, if the supply of the fluids be cut off, as in the operation for aneurism, the irritability, as well as sensibility, is reduced to the lowest ebb, and returns only as the circulation is restored.

Fifth law.—In the development or exercise of irritability, the state of the fluids manifest a marked influence. Black blood passing into an organ soon determines a suspension of its irritability and consequently of its vitality. It acts in this manner on the brain, the heart, and other organs, when respiration is interrupted. This cessation of the action of the heart, does not result, as is satisfactorily shown by Bichat, from a defect in the stimulation of black blood in the cavities of the left side of the heart, but from penetrating into its substance, by the coronary arteries, and the consequently diminished susceptibility to receive impressions, or to respond to the stimulus of its natural energizer, the blood.

Sixth law.—The facility of the circulation of the fluids, is connected with the manifestation of irritability. The example afforded by the operation for aneurism, has been already adduced, as exhibiting this connexion. Increase of circulation, afflux of arterial or oxygenated blood, and increase of irritability are closely concatenated, they cannot be separated; and it is difficult to assign a precedence to either, in the sequence they observe.

When a part is irritated, the fluids rush to it from all the surrounding points; they abound in it more largely than in a natural state; its vessels act with more vigour; and it becomes more susceptible of the action of irritants—that is, its irritability is increased. If the irritation be intense, the fluids are detained in the irritated part, not only in its vessels, but in the interstitial or areolar spaces; congestion ensues, which terminates in a complete remora of the circulation. The irritability follows the same course. It is exalted with the afflux and rapidity of the circulation; declines as it becomes enfeebled and congestions are formed; and it is extinguished with its cessation.

Seventh law.—Irritability does not exist in an equal degree,

in all the tissues and organs; and, consequently, they differ widely as to their susceptibility of receiving impressions.

The following is, probably, the series of organs and tissues, in relation to their irritability. The cerebral and nervous tissue, (medulla oblongata, medulla spinalis, cerebrum, and cerebellum;) the mucous membranes, internal and external; pia mater; lymphatic vessels and glands; muscles; serous membranes; cellular tissue; parenchymatous organs; ligaments of the joints; periosteum; cartilages and bone.

Eighth law.—The irritability being increased in one, two, or three, (it very rarely is in four,) organs or tissues, it is correspondingly diminished in all the other organs and tissues. The phenomena of disease, constantly illustrates this law. In hydrocephalus, the bowels are often impassable to violent irritating and drastic purges. In pneumonic inflammation, the stomach is scarcely sensible to enormous doses of tartarized antimony, ipecacuanha, &c. The skin loses its irritability, especially on the extremities, in gastritis, gastro-enteritis, colitis, when intense, or they have degenerated into a chronic state, and have terminated in ulcerations of the mucous membrane. When internal inflammations are very intense, death of the skin and extremities ensue many hours previous to the death of the lungs, heart, and abdominal viscera, as is seen in yellow fever, at times, in bilious fever, &c. Here the irritability, the circulation, all the remaining energies of life, become contracted within a small circle, gradually decline, and finally cease in all the periphery of the body drawn from it by intense and concentrated action of the central organs.

Ninth law.—Within certain limits, irritability increases with excitement, or in proportion to the action of stimuli. It always diminishes by the abstraction of stimuli in the part whose organizations are *directly debilitated.*

It was a capital error in the doctrine of Dr. Rush, who laid it down as an axiom, that debility produces an excess of excitability. Debility of the organizations is uniformly characterized by a diminution of susceptibility to impressions, of action, and of function; all the phenomena of life are below their normal condition. The error of Dr. Rush was occasioned by adopting the views of

Brown, who regarded excitability as "a unit, or a simple and indivisible substance."*

Nothing is more common than to confound irritability of an organ, that is, its increased susceptibility to exciting or stimulant impressions, which has been shown to be a consequence of its state of sur-excitation for debility. This almost daily occurs in numerous diseases. Irritation of the stomach, eye, lungs, &c. interrupting their functions, is mistaken for debility; while the loss of function, attributed to debility, is, in almost every case, a consequence of irritation, or excess, and not deficiency of organic actions.

The preceding I take to be the general facts or laws of irritability, as derived from an attentive observation and analysis of the phenomena, healthy and diseased, physiological and pathological, that are manifested throughout living, organized structure.

The more I reflect on this vital property, the more thoroughly I am persuaded of the importance of having its manifestations, and the phenomena depending on it, investigated and generalised. The present attempt, hastily executed, is not offered as absolutely accurate, but merely as an essay to the determination of this interesting subject.

Sect. II.—*Organic, or Vital Affinity.*

In speaking of the vital properties, it was mentioned that irritability, or the aptitude, or susceptibility of organized matter to receive the impression of excitants, was the principal, and by some, is regarded as the only vital property. With the results of this property we are familiar; they are obvious to our perceptions; its manifestations can be studied, and its facts reduced to general formulæ or laws. There exists, however, another that merits equally the term vital, and like irritability, is common to all organic matter. Its phenomena are, however, obscure; it has attracted as yet but little attention, and its facts are but imperfectly understood. This property is, notwithstanding, connected

* Medical Inquiries and Observations, Vol. I. p. 9.

with every vital action; it is the essential and immediate agent of nutrition and the secretions; it maintains organized or living matter in its state of composition; enables it to react against, or resist the influences that tend to its destruction, and opposes the exercises of the laws of common affinity or general chemistry, which resume their sway on its cessation. This property has the strongest analogy to chemical affinity, and may be termed organic or vital affinity. It may, in its nature or essence, be the same as chemical affinity, but is modified by the remote or first cause of life, and operates under different laws.

In organic matter, nature employs the same materials as exist in inorganic matter, though invested with dissimilar forms; and the same general forces or powers that prevail in the last, are the immediate agents in developing the actions, and regulating the phenomena of the first under a different and modifying, but unknown principle. As this principle is wholly inscrutable, and is only made known by the manifestations it induces in organized matter, and the modifications to which it subjects the general forces of nature, for the production of its peculiar phenomena; it is to these our researches and scrutiny into vitality, in all its actions, must be restricted, without plunging into abstruse and metaphysical inquiries concerning its abstract or essential nature. By pursuing this course, we avoid equally the hazards of a gross and degrading materialism, and the inconclusiveness and errors arising from a loose ontology.

Life, we have seen already, is organic matter in action. But every vital action, from the first vital movement of the incipient germ, is accompanied with a change of the organic elements or molecules; a change that appears to destroy their capacity for vital phenomena. Hence is necessitated their renewal by the addition of exterior matter, and its assimilation to the same nature as the organic matter itself, both for its continuance in proper form, and for its progressive development. This operation is the result of what is named organic or vital affinity, which is thus, a vital property, and at the same time, the effect and cause of vital actions. The process by which organized matter is thus renewed, requires the fluid form as one of its elements. The organic actions consist in the united movements of the solids and fluids, in proportions, in the healthy state, always definite for each parti-

cular species of structure or organic composition. The same is equally true of the secretions, which require the action of the solids and fluids in a certain limited ratio. Within this extent the nutritive and secretory actions are duly performed; the play of the vital or organic affinity occurs in regular order, and healthy or natural structure, and function prevail.

But let the organic or secretory actions be excited, or in excess, that is, let irritation be developed, and the fluids are in excess; they surpass their healthy proportion in relation to the solids; their movements become embarrassed, or nearly cease; congestion results. This condition of the organs influences the action of organic affinity; the result of which assumes various characters, determined by the state of the organic actions, of the circulation of the fluids, and other circumstances not completely understood. Thus the organic affinity acts sometimes in excess, when nutrition becomes excessive, and produces hypertrophia, as is seen in the heart, and the muscular tunics of intestines, in muscles unduly exercised, &c.; or it is denaturalized, whence arise anormal tissues, as the conversion of mucous membranes into cartilage, of serous tissue into bone, &c.; or the development of irregular formations, as melanosis, tubercles, &c.; or it becomes irregular, whence are caused softening of tissues, ulcerations, &c.; or it totally ceases, when death ensues, and common chemical affinity assumes its sway.

Analogous effects are produced in the secretions; they are augmented in quantity by a more active display of organic affinity; they are changed in quality, or totally denaturalized, when it is perverted in its action; or they are wholly suspended according to the extent of the accumulation of the fluids from irritation, and the too active movements of the solids.

The immediate or proximate agent by which the effects of organic affinity are operated, is not certainly known. Many circumstances render it very probable that it may be electro-galvanic energy or influence. This force is the active agent of chemical affinity, and its opposite state of positive and negative in the molecules or atoms of inorganic matter, produces the innumerable and immensely diversified forms it assumes, and phenomena it presents.

In the production of the organic phenomena from the princi-

ples we have laid down, it may be presumed, that this principle is also the immediate or proximate agent of organic affinity, acting in conformity to the laws of vital energy or organic force, and displaying definite effects as it is brought into a specific mode of action in every definite specific structure.

That the electro-galvanic power is the immediate agent, or proximate cause of most, if not all the nutritive or reproductive and secretory phenomena, may be inferred from the following considerations.

1st. It is the universal agent in all the atomic or molecular changes in inorganic matter, and the productive cause of all the phenomena connected with its various forms.

2d. Organic matter is the same in its nature as inorganic, differing only in form and proportions; and in the organic, reproductive, and secretory functions, all the actions are molecular or atomic; and hence it is reasonable to conclude, that the same force is the immediate agent or proximate cause of the molecular or atomic actions of matter in all its forms, organized and inorganic.

3d. The compositions and decompositions resulting from the electro-galvanic force, are analogous to those that are observed to occur in the organic actions and secretions.

4th. That all the atomic changes accomplished by the electro-galvanic force, or active power, are accompanied with development of heat; and the organic or nutritive, and the secretory actions are, in a natural and healthy state, attended with the elimination of low degrees of caloric producing animal heat. Spontaneous combustion, of which so many examples are on record, has every appearance of being an intense, electro-galvanic action, in a system highly charged with inflammable materials, (hydrogen, carbon, nitrogen,) producing a rapid combination with oxygen, and which, as in all other circumstances, is attended with disengagement of light and heat, and decomposition or change of form.

5th. In the organism of the higher animals there exist electromotive apparatus, excellent electric conductors, insulators, and exciters. Thus muscular contraction is excited by completing an electric circle composed of muscle and nerve. The nerves are among the best conductors of the electric power; and in some

animals, as the gymnotus and torpedo, &c. a complete electric organ composed of nervous matter, and insulating, or non-conducting plates is provided, and which excites powerful electric shocks.

6th. The electro-galvanic power is found to supply the absence of nervous influence in some functions, that are suspended by the division of the nerves, as digestion and respiration, when the par vagum is divided. It is also the exciter of muscular contractions when directed through a nerve, in a manner analogous to the nervous influence itself.

Lastly. By direct experiment the fluids of the organism are shown to be electric in a uniform state and degree in health. That of the blood is positive; in inflammatory diseases its electricity diminishes, and is always lower when the inflammatory buff forms on blood.

It is not to be presumed, however, as some writers have been disposed to advance, that the human system is an electro-galvanic apparatus, or that this power is the same as the vital or organic force. The admission of the agency of this principle, cannot be extended further, than as a mean subordinate to the vital principle or organic force, employed in perfecting certain actions of which it is an operative cause.

Whatever may be the nature of the agent, by which the phenomena of organic or vital affinity be accomplished, the fact of its existence cannot be questioned. The nutritive humour in the blood is a homogeneous fluid. As it circulates through the various organs, each receives the materials of which it is composed. In muscular tissue, muscle is formed from it; in nervous tissue it produces nervous substance; in glandular tissue, glandular structure, &c. The same is true of the secretions; each gland separates from the blood its peculiar fluid; the kidneys, the urine; the liver, bile; the parotids, saliva; the testicles, semen.

The blood contains the elements of all the solids or organs, and either the elements or the materials of the secretions. That these different and varied formations should proceed from the same homogeneous fluid, can only be an operation of affinity. There is no other known force or power in nature by which it can be accomplished. It differs, however, from common affinity, or of inorganic matter, by the invariableness of its action, and the regularity of its

effects; but this is only apparent, and arises from acting constantly under the same circumstances, and is a result of the first, remote, but unknown principle of life. Every organ is an apparatus, in which organic affinity in a healthy state, is made to act in an invariable mode. Inorganic affinity, similarly circumstanced, would exhibit the same regular and constant production, as is observed in an apparatus in which it is brought to exert its play in a fixed and certain order.

Organic affinity appears to be influenced by external causes or agents, and to this circumstance is to be attributed some of the phenomena in the morbid states of the organized system. Thus an atmosphere vitiated by too many individuals crowded in a small space, enfeebles organic affinity, and a general disposition to decomposition of the solids and fluids ensues, as is seen by the production of hospital gangrene in crowded wards, in which ulcerations and gangrene result from very feeble excitation of the organic actions. Many of the poisons exert a similar influence over the play of the organic affinities, especially of the blood. May not the peculiar and characteristic symptoms of scurvy depend on an enfeebled condition of the organic affinity, modifying the result of inflammatory or irritative actions in the tissues?

At present we are not at liberty to do more, with the limited number of facts and observations we possess, and the little light that has, as yet, been thrown on the subject, than to invite attention to its further consideration, and present what may be regarded as probable circumstances.

Some of the generalities or general facts of vital affinity may be pointed out; others doubtless exist which may be developed by future observation.

The following may be regarded as clearly established.

1st. It is operative both in the solids and fluids, in health and in disease, and is the immediate agent by which is accomplished the composition of the solids, and formation and constitution of the fluids, in both states.

2d. It is immediately connected in its exercise with the organic actions, from which it is inseparable, and of which it is an element. It consequently participates in all the deviations of the organic actions from a natural condition. Hence the morbid states

of the organic actions are always accompanied by alterations of structure and vitiation of the secretions.

3d. It is influenced by the condition of the fluids. When from any cause, as the want of proper alimentation, or defect in the excrementitious or depuratory processes, or from interruption to healthy sanguification in the respiratory apparatus, the blood has its elements in an unnatural state, organic affinity departs from its regular order. Hence the decomposition of the solids, ulcerations, and tendency to the putrescent state, both in solids and fluids, that occur under these circumstances.

4th. It is modified by external agents, both in the solids and fluids. The state of the atmosphere exercises an extensive influence on this property. This is manifested in fevers having strong putrescent tendencies, generated in localities where the air is vitiated by excessive crowding; and in the production of asphyxia, by certain exhalations and gases. Some poisons appear to act in this mode on the blood, when introduced into it, depriving it of its vital character or organization, as it may be called; such is the poison of the rattlesnake, viper, &c.

5th. Some medicines, when the organism is highly charged with them, appear to render organic affinity irregular in its action, or to enfeeble its powers. Mercury, for instance, produces, when the economy is kept under its action, a strong disposition to ulceration, especially in soft and highly vital structures, as the tegumentary tissues; ulcers, when already existing, lose their disposition and capability to cicatrize; they slough with extreme rapidity, the surrounding parts being incapable of resisting the process of dissolution, or of maintaining their organic composition. I have known instances in which corrosive sublimate, abusively administered, produced a condition of the solids, which incapacitated them for the slightest restorative action. The least abrasion, even the prick of a needle in sewing, or scratch of a pin, could not be repaired, but was succeeded by an ulcer. Iodine occasions similar effects.

Sect. III.—*Organic Actions.*

Organized matter exists in two states, the one moveable, the other fixed; or fluid and solid. Vital phenomena cannot be mani-

fested by either separately, but the concurrence of both is indispensable for their production.

Organized matter, endowed with organic force or irritability, reacts on the impression of external stimuli or excitants. This reaction, from which proceeds vital phenomena, consists in a molecular action, excited and maintained between the two states of organized matter on the solids and fluids. This combined action of the solids and fluids constitutes THE ORGANIC ACTIONS. They are the first and direct product of the conditions of vitality, (organs, organic force, and external impressions.) They consequently are vital actions, depending on the vital forces or properties, (organic force, and vital affinity,) and the energizers of vital actions, (stimuli,) and exist in all organized structure, animal or vegetable. The molecular action, in which the organic actions consist, is nutritive, reproductive, or formative; the solids assuming the fluid state, and the fluids becoming solid. They are attended with a decomposition and a formation.

The organic actions are common to every tissue and solid of the animal structure, but exist in very different degrees of activity in each, adapted to its especial character and the functions it executes. This activity always bears a relation to the proportion of the solids and fluids of a particular structure. It is most exalted in those structures, where the especial nutritive humour, or arterial blood, within a certain limit, bears the greatest proportion. In all those tissues in which the solids are plus and the fluids minus, as cartilage, tendon, ligament, bone, &c. the organic actions are feeble. Whenever they do increase, as in the inflammations of these solids, the proportion of fluids augment; the two proceed pari passu, and these organs acquire a new character and a higher elevation in the scale of vitality.

The organs and tissues whose organic actions possess the greatest energy, and which are of the highest vital order, are exceedingly vascular; the fluids abound in them, and exceed in a given proportion the amount of the solids. These are mucous membranes, glandular, parenchymatous, and nervous tissues. These tissues undergo changes in their structure, the consequences of chronic inflammation, by which their vascularity is diminished, and the proportion of their solid matter advances upon that

of the fluids. Their organic actions diminish in the same degree, and they are degraded from their rank in the order of vital tissues.

When the fluids are observed to be in the reverse state, or in excess to a considerable degree, beyond the proportion natural to the structure which has taken it on, the vital properties or forces, (organic force and vital affinity,) are diminished; the organic actions are enfeebled, or entirely cease; the organ loses its natural structure, and its functions are perverted, disturbed, or abolished. This condition prevails in congestions, and is manifested in the congestions of the brain, lungs, liver, internal mucous tissues, &c.

The generalities or laws of the organic actions, may be included in the following series or formula.

1st. The organic actions result from the reaction established between the internal conditions of life, (organs, organic force, and vital affinity,) and the external conditions of life, or stimuli.

2d. Their intensity is commensurate with the sum of the internal conditions or vital properties, and with the quantity and quality of the external conditions or excitants.

The augmentation of the vital forces or properties, by the increased aptitude to react on the impressions of stimuli, that is thus acquired, is productive of increase of the organic actions: a corresponding relation exists between the organic actions and stimuli; they augment with an increased quantity of the same excitant; they decline with its diminution. What is the relation between the quality of an excitant, and the organic actions, and how far they are modified or acquire a peculiar character by the quality, is a point that remains yet to be decided.

In health, a certain relation prevails between the organic actions, and the internal and external conditions of their production, which is especial for each solid, and which tolerates a certain range. When this relation is lost in any respect, structural derangement ensues, functional acts become irregular, and disease is developed.

3d. The organic actions are common to every tissue and solid of the animal economy, but differ in each according to its particular organization: consequently the same agent will not affect them all equally, or occasion in all similar phenomena. This is a leading cause of the diversity in morbid phenomena, or symp-

toms of disease, and of the differences in the therapeutic actions, or the effects of medicines and other remedial agents.

4th. The organic actions, the vital forces, and the circulation of the nutritive fluid or humour, are mutually connected and dependant. They cannot be separated, but are concatenated in the most intimate union. It is impossible to point out the order of their connexion; the one immediately proceeding from the other, constituting a circle of causes and effects; "abeuntes in circulum." They are consequently the measure or standard of each other's force and activity.

5th. The organic actions being essentially nutritive or formative, their vitiation or departure from a natural state is attended with a consequent change of structure, and alteration of function. When these modifications proceed from an agent acting by a dynamic force, and not chemically on the organization, the organ, from the change induced in its organization, and its organic force or irritability, becomes adapted to the impression of that agent, and ceases to manifest any marked effect, or peculiar action from it, at least in the degree it originally caused. This explains the tolerance acquired by the organs to morbific impressions to which they are exposed for a length of time; and the diminution or cessation of the effects of medicinal remedies administered for a considerable period.

The subjects of the foregoing remarks have been; 1st, an analysis and examination of the elements that compose the organism, the tissues, and the organs; or the solids and the fluids in their natural and pathological states: 2d, an investigation of the forces or powers by which they are enabled to enter into action; and the actions of which the elementary tissues are the seat.

The organs, in addition to the organic actions, execute functional actions, which become affected by every deviation of the organic actions. The disorder of function constitutes the symptoms, or announces the existence of disease. It is the sign addressed to the senses, or is the language of suffering organs, which the practitioner should be able to understand, and translate with correctness, so that he may locate the affection in its proper organ, and appreciate its true character. A general consideration of the different functional acts, presents itself next in order, as a necessary subject of inquiry.

CHAPTER IV.

Of the Functions.

The organs of which animals are composed differ in each genus. As their actions constitute life, there must exist a consequent difference, or modification of vitality, depending on the organization in each genus of animals and vegetables. The organs are the most numerous in man, his organization is the most complete, and his life the most perfect.

The organs execute particular offices necessary to the life of the individual, and the propagation of the species. Their offices are named functions. Life is maintained by the functions; they are, as Richerand expresses it, the means of existence; and every disorder of function, is an aggression on the powers of life.

The functions are more or less numerous in animals, according as their organization is more or less complete; and they differ from each other by general and special characters. The general characters, and which are essential to constitute a function, are, 1st. That it performs a particular office in the economy. 2d. That it has an organ, or an apparatus of organs, destined to its accomplishment. Without these united circumstances, no act in the economy can be considered a function. The special character is derived from the nature of the office each function fulfils, and the organic actions of which it is composed, or which is its basis.

From a neglect of the requisites of a function, physiologists have widely differed as to the functions themselves and their number. A different enumeration has been made by almost every writer. Passing by the various views that have been presented in this respect, the following will be found to comprehend all the offices of the organs that can properly be designated as functions.

1. Digestion. 2. Absorption. 3. Respiration. 4. Circulation. 5. Assimilations, or nutritions proper. 6. Calorification. 7. Secretions. 8. Innervation. 9. Sensibility, or sensations 10. Intellectual and pathetic faculties. 11. Locomotion, or voluntary movements. 12. Expressions. 13. Generation.

No less difference has prevailed as to the classification of the functions than their enumeration. A perfect arrangement of them is not to be expected. They are intimately connected; they have a common end to fulfil; they often depend on each other. It is then difficult to separate them completely, and discover a starting point.

The classification of M. Richerand, with some slight modifications, is that which offers probably the fewest objections, and is most generally adopted. It is essentially the same as that of Bichat, but with more correctness in its details.

The functions constitute two classes. 1st. Those necessary to the life of the individual. 2d. Those necessary to the preservation of the species. The first class contains two orders. The first order embraces those functions devoted to nutrition, that are destined to the assimilation of the aliment by which the individual is nourished, that are appropriated to the proper substance of the individual; the second order consists of those functions by which the individual maintains relations with the objects by which it is surrounded.

The functions of the first order, or those of nutrition, are, 1. Digestion, which prepares the nutritive portion of aliment. 2. Absorptions, by which the product or humour of digestion is carried into the mass of the humours. 3. Respiration, which combines oxygen with it. 4. Circulation, that distributes it to all the organs. 5. Assimilation, that converts it into the proper substance of the individual to repair its losses. 6. Secretions, eliminating a part of the sanguine mass. 7. Calorification, maintaining the animal heat at a certain degree. 8. Innervation, or the nervous energy that sustains the movements necessary to the preceding functions; the immediate organ of which, there is every probability, is the ganglionic system of nerves.

The second order of functions, or those of relation, have, for their instruments or organs, the cerebro-spinal nervous apparatus, and are; 1. sensibility or sensations, by which the impressions received by the different organs of the body are perceived; 2. intellectual and pathetic, or moral faculties. The first receives, retains the sensations, compares them, judges of them, combines them: the second determines to seek or to avoid the causes of the sensations, creates desire and aversion. 3. Locomotion or volun-

tary movements, by which a part, or the mass of the body, may be moved at will to satisfy desire or aversion, or for the acts necessary to conservation. 4. Expressions, by which ideas, sentiments, and feelings are communicated.

The second class of the functions belonging to the species, and intended for its conservation, consists of generation, and is common to both sexes, or is deputed to the female.

The functions have already been defined and enumerated. They are the actions of the different organs of the human body, and from which result the accomplishment of their different faculties, the conservation of the individual, and the continuance of the race. Like all the other actions of natural bodies, they offer some phenomena appreciable by the senses, while others pass in the molecular structure, and are not to be perceived.

The first can be described in the manner in which they occur; the last are to be known only by their results. The actions of the organs, or the functions, cannot be known otherwise than by the material conditions of their production and connexions. It is impossible to penetrate their essence. The general or special forces, under which they are immediately produced, can, in most instances, be determined only in a general manner as vital forces or properties, without pretending to ascertain their essential nature.

In examining the functions, some physiologists commence with those of nutrition, and others, with those of relation. This last I shall adopt. The functions of relation affect the acts by which nutrition and reproduction commence, and which are essential to the execution of all the other functions. Besides, some of the functions of relation are blended with those of nutrition and reproduction so intimately, that they must be known to comprehend the others. In addition to these reasons for commencing with the function of relation, it may be further added, that having the nervous system for their apparatus, and which, in some of its portions, is connected with the performance of every other function, these cannot be well understood without an acquaintance with its influence, its functions, and modes of action.

Sect. I.—*Functions of Relation.*

The functions of relation are four in number: sensibility, or the sensations; the intellectual and moral actions; voluntary movements; and lastly, the expressions.

The possession of these functions elevates man to the head of creation. In their exercise he acquires consciousness, or a knowledge of his existence, and they form the links that connect him with the exterior world. To them is he indebted for the exalted privilege of acquiring a knowledge of the existence of his Creator, and of offering to the Supreme the homage of his worship and adoration. They render him in their healthful exercise, a moral and responsible agent, and through them he possesses the animating and ennobling prospect of a future state of existence.

In man and the superior animals, the nervous system, in its totality, constitutes the organs, apparatus, or instruments, or the material condition, of the functions of relation.

This system, we have already said, does not consist of a single organ; is not simple and homogeneous in its structure, but is a collection, a reunion of numerous organs, and of complex and diversified organization.

In a first division, it is to be distinguished into four parts, each of which admits of other divisions. The primary divisions are, 1st. The encephalon or brain; 2d. The medulla spinalis; 3d. The cerebro-spinal nerves, and nervous tissue, or expansions in the organs; and 4th. The great sympathetic or ganglionic system.

The encephalon or brain consists of three distinct portions; the cerebrum, constituting its anterior and superior part; the cerebellum placed behind and below; and the medulla oblongata, or meso-cephalon, situated at the base, and is continuous with the medulla spinalis.

These different portions are again composed of groups of organs, forming apparatus charged with the performance of especial offices or functions. The cerebrum comprehends the organs of the intellectual and moral faculties. The offices of the cerebellum are yet undecided, but Flourens, Bouillaud, and Magendie, have rendered it exceedingly probable, that in at least a part of its offices, it is connected with the voluntary movements, co-ordinating

them when commanded by volition, so as to combine the actions of all the different muscles requisite to execute or complete any given motion, or series of motions, as in standing, walking, running, leaping, dancing, or any other movements, requiring the contraction of more than one muscle for its performance. Lastly, in the medulla oblongata is embraced the organs of sensibility or the sensations; the organs exciting muscular contractions or voluntary movements, connected with which is the expressions of the moral emotions or passions; and the organs that activate and maintain the movements demanded for the performance of respiration.

Two different substances are observed to enter into the composition of the encephalon. They are the white, fibrous, or medullary substance, and the ash-coloured, gray, or cortical substance. The first is much less vascular than the last, the vessels appearing chiefly to traverse it, without ramifying; while the gray substance is highly vascular, and appears, when injected, almost as a congeries of minute vessels.

This difference of structure is prima facie evidence of a difference of office or function. From the principle, which, it is conceived, is now clearly established, and which has been adopted throughout this work, that organization is a necessary condition to the manifestation of vital phenomena, it is a direct conclusion, that difference of structure implies a difference of phenomena; and that difference of phenomena is an indication of a difference of structure.

The relations the ash and medullary substances uniformly bear to each other, and the disposition they invariably observe, are corroborative evidence of the differences in their nature and offices.

The white or fibrous substance is employed to form the nervous cords, the exterior of the spinal marrow and medulla oblongata, the crura-cerebri and cerebelli, and the principal part of the interior mass of the cerebrum and cerebellum.

The gray substance is never seen to enter into the composition of nervous cords. It is found in masses in the interior of the spinal column; it forms masses also in the medulla oblongata, and in the crura; it is spread as a layer over the tubercula optica, or quadrigemina, and the thalami optici; it is disposed in alternate layers in

the corpora striata, and covers the exterior convolutions of the cerebrum, and the laminæ of the cerebellum.

The fibres of the medullary or white substance always emanate from, or terminate in gray substance; and wherever there is a new addition or increase of the white, fibrous substance, gray substance is always found, as though provided for that purpose.

From these circumstances, Gall considered the gray substance as the matrix, whence was produced the white, fibrous substance. This is, however, a vicious mode of regarding the structure. Parts do not pullulate or grow out of each other in this manner. The relation pointed out between these two substances, does not consist in a mere provision of gray substance, that medullary substance may grow from it, but that different functions are to be performed, and consequently that a different structure is to be provided. The connexion between them is an evidence that both must concur to produce certain phenomena; and that they are different organs of the same apparatus.

Experiment affords demonstrative evidence of the difference of function. When the fibrous or medullary substance in the medulla oblongata, in the spinal column, or in the nervous cords, is irritated, either pain, or convulsive motions of muscles are produced, according to the part on which the experiment is made. If the gray or cortical substance be treated in the same manner, neither of these effects result; there is neither pain nor sensation. The functions of the two cannot, therefore, be the same.

Experiments and observations clearly establish, that the office of the nerves is to conduct or transmit impressions or stimulations, from the surfaces of relation to the central, nervous organs in the brain, and to convey, from the cerebral organs into the organs of the economy, the nervous stimulations, as of volition, of the passions, &c. to which they give origin.

The office of the white or fibrous substance in the nerves and spinal marrow, it is thus demonstrated, is to transmit or conduct stimulations; and the same office is to be attributed to this substance in the other portions of the nervous structure. It is the gray substance, then, of which the nervous organs, executing, manifesting, or originating the nervous functions, and displaying nervous phenomena, must be composed.

The largest quantity of gray substance is found in the cerebrum, covering the convolutions, and disseminated in some portions of its interior, and it is there we are to look for the most numerous, and the most important of the nervous organs, or the material condition for the production of nervous phenomena.

The medulla oblongata, situated at the base of the brain, is of a quadrilateral form. In consists of several fasciculi, or bundles of nervous fibres, with some masses of gray substance. Four fasciculi are easily recognised, but others may possibly exist.

Two are anterior, and advancing upwards they increase, and receive additions of several masses of gray substance, forming successive enlargements, that are named corpora pyramidalia and olivaria, tubercula quadrigemina or optica; and to these may be united the thalami and corpora striata. The fasciculi of these fibres constitute the crura cerebri, which diverge and expand, so as to form the interior white, fibrous, or medullary substance of the brain.

This portion of the medulla oblongata is connected with the nerves of the senses, or, in common language, the nerves of the senses proceed or emanate from it; and evidence is thus given, that it includes the organs of the sensations, or of sensibility.

The two posterior fasciculi, with the addition of gray substance, produce the enlargements named corpora restiforme, and then constitute the peduncles, or crura, of the cerebellum, which, by diverging and expanding, form its fibrous or medullary substance.

From the medulla oblongata also emanate the nerves that sustain the movements of the muscles occupied in respiration, and which direct and combine their movements for the performance of that function. It gives origin also to the nerves that impress on the muscles of the countenance, the particular movements excited by the moral affections; and which express the passions in the physiognomy. From this point proceed, in addition, the nervous columns that furnish nerves to the muscles of the voluntary movements.

The medulla oblongata is thus seen to be a central point, where a reunion is formed of the medullary or transmitting fibres of the cerebrum and cerebellum; of the organs of sensibility, and of voluntary movements; of the respiratory acts and the expressions.

Continuous with the medulla oblongata is the medulla spinalis. The point where it commences is not agreed upon by physiologists and anatomists. The point where the decussation of the fibres end, may, with strong grounds, be regarded as the termination of the medulla oblongata.

The medulla spinalis is divided on its anterior and posterior surfaces, by a furrow in the median line, into two similar halves. On the sides it is again divided by a furrow, from which pass off the roots of the vertebral nerves, into anterior and posterior columns. In its course the spinal marrow gives off thirty pairs of nerves; the roots of which, emanating from the anterior and posterior columns, are separated from each other by the denticulated ligament. Those nerves coming from the anterior column have each a ganglion.

These nerves pass through the inter-vertebral foramina, and are distributed to the skin, the organ of touch or tactile sensation, and to the muscles of voluntary movements. These nerves, and the fasciculi of nervous fibres, or columns of the spinal marrow, from which they emanate, do not execute the same functions.

The nerves that communicate with the posterior columns, as well as the columns themselves, transmit impressions on the periphery of the body to the medulla oblongata, and thus determine the sensations of touch, of temperature, &c.

The nerves that communicate with the anterior columns, together with those columns, on the contrary, transmit to the muscles the internal or sensorial stimulations, and occasion their contraction. When in health, these stimulations proceed from volition, and the voluntary movements are accomplished; but when they are the effect of morbid irritations, they cause convulsions, spasms, &c.

According to their origin, the nerves are named encephalic, or spinal. Of the first, there are nine or ten, according as the seventh pair is considered a single nerve, or two, which it really is. They all commence with a number of fibres, or threads, and originate, are implanted in, or communicate with gray substance.

The nerves consist of distinct filaments, united by cellular tissue, and contained in a general envelope, called neurilema. In their course they ramify into numerous branches, anastomose together, and often are interlaced in an inextricable manner, form-

ing plexus. They have sometimes enlargements, called ganglions.

In the last degree of ramification, the nerves terminate in three different manners; 1st, by a union with other nerves; 2d, by uniting with the great sympathetic; 3d, by expanding and forming nervous tissues in the organs, or what is more correct, uniting with nervous expansions or tissue, which enter into the composition of the organs, and which are the seats of the sensitive impressions.

From the organs or instruments of the functions of relation, we now pass to a general consideration of the phenomena they offer to observation, or the functions themselves, regarded in the mode of their production, and the physiological and pathological conditions of their existence.

§ 1. *Sensibility, or the Sensations.*

Sensibility, or the sensations, are the function by which impressions made on the organs of the senses are perceived; in the action of which consciousness exists, and by which the exterior world is made known.

The sensations all result from an impression on, or a movement excited in, a surface of relation. As Gall remarks, they are the perception of an irritation. The surfaces of relation are, externally, the five senses; and internally, the mucous membranes, and their appendances.

The external sensations are caused by the contact of the organs with external matter; or, in other words, by excitation or irritation awakened by exterior agents in the surfaces of relation. The internal sensations arise from modifications of the actions of the internal tegumentary tissues or interior surfaces, and bear the strongest analogy to irritation.

By the external senses is acquired a knowledge of the properties of matter, and the condition in which it exists; as the resistance of matter by touch, the colour of matter by vision, the vibration or sound of matter by hearing, the sapidness and solution of matter by taste, and the effluvia or æriform emanation of matter by smell.

The internal senses, inform of the wants of the economy, and of the states or actions of the organs.

In the exercise of the sensations are the sources of our pains and our pleasures. They acquaint us with the relation of exterior matters to our economy, and as the sensations they create are pleasurable or painful, we are excited to enjoy, or warned to avoid them.

The sensations bestow the capacity for social enjoyments, which induce man to enter into, and live in society; and by the happiness and pleasure mutually inspired, they invoke the sexes to a union, whence are formed domestic relations, the most sacred of the social connexions, and are called into exercise the most tender of human sympathies. Thus do the sensations preside over the individual existence, the maintenance of social relations, and the continuance of the species, or propagation of the race.

§ 2. *Of the Mechanism of the Function of Sensibility.*

The sensations are the perception by the intellect or soul of impressions or movements in the organs. When an impression, made on a surface of relation, as the skin, by a foreign body, is perceived by the intelligence, and which is called touch, sensation exists. The perception of the condition or movement of the stomach, when it requires aliments, and which is called hunger, is equally a sensation.

The sensations are very numerous, and arise from external or internal causes, whence they are divided into external and internal.

Every sensation, either internal or external, healthy or morbid, is referred to the organ that immediately receives the impression by which it is occasioned. Hence it might be inferred, on a slight examination, that the organs in which the sensations are felt, are also their seat. Gall, without positively affirming the fact, is inclined to this belief. It cannot, however, be sustained when the phenomena of the sensations are more closely inspected. We shall then see most conclusively demonstrated, that no sensation does, or can exist, unless the impression received by the remote organ is transmitted to the brain, and which is acted on, or influenced by the transmitted impression.

This corollary is clearly established by the following facts:—

1st. Let the communication between an organ of sense, or a

part the seat of an internal sensation, be interrupted by the division of its nerve, or ligature placed on it, no matter what may be the degree of impression made, no sensation is experienced.

2d. When the brain is incapable of acting, as when compressed by effusions, or by depression of bone, or is torpid from large doses of opium, notwithstanding an organ may be in the condition to experience sensitive impressions, still no sensations can be produced. The same circumstance is observed when the cerebral organ is deeply engaged in its own peculiar actions, as in profound meditation, at which time powerful impressions do not produce sensations. The story of Archimedes furnishes an example, who, deeply engaged in the solution of a problem, was unconscious of the assault on Syracuse and its capture. Soldiers in charging, when highly excited, are wounded without feeling the impulse of the ball.

This principle has an application to pathology. The brain, when the seat of phlogosis, or irritated, is incapable of responding to sensitive irritations proceeding from other organs, and no pain is experienced, though they may be the seats of active inflammations.

3d. Impressions that are feeble, or scarcely perceived, become strong and intense, when the action of the brain is directed towards them by the will or attention.

4th. The brain is capable of producing sensations independent of impressions. This occurs in dreaming, when we hear sounds, see and feel objects, though no impressions are, at the time, made on the organs, the seats of those sensations. The same occurs in delirium, and in mental alienation, where the patient experiences sensations that are entirely generated in the brain, and without corresponding impressions in the surfaces of relation. After amputation of a limb, for many years sensations are experienced of its movements, precisely as though it continued to exist.

From these facts it is not possible to question the inference, that the transmission to the brain of the impressions made in the remote organs or surfaces of relation, is essential to the production of sensation.

In the production of every sensation, there must consequently concur three separate actions; 1st, that of the organ in which the impression is made, and to which the sensation is referred; 2d,

that of the brain which receives this impression, and which constitutes the sensation; and 3d, that of the nerve, or the organ intermediate to both the others, transmitting the impression from the one to the other.

Every part is not equally capable of receiving impressions, and consequently vary as to sensibility. There is no part of the body that may not become sensible, or acquire the capacity to respond to the action of impressions. Parts naturally insensible do not, however, acquire this property without undergoing a change in their structure, as bone, ligament, serous membrane, &c. They become more vascular, and change their general nature.* It is most probable that every part possesses some nervous structure, too minute to be detected, or to display well-marked phenomena, but which receives increase and development with the change induced by disease. This affords additional evidence, that morbid irritation is an increase of the nutritive irritation. It may, however, be confidently relied on, that no sensation can exist without nerve, and that wherever sensations exist, there must nervous structure be present.

It is to be concluded, that the impression, the first element of sensation, is an action or irritation occasioned in the nerves, or nervous expansion or tissue of the part to which it is referred, by an exterior body when such is applied; or by a transmitted or sympathetic irritation when it is not excited by an exterior body.

The action of perception, it has been shown, occurs in the brain, and is most probably the repetition of the action or irritation which has been occasioned in the nervous extremities or expansion in the organ. If the condition of the brain is such as to prevent this repetition of action in it, as when it is diseased, torpid from sleep, or narcotics, or is engaged in its own acts, perception is not produced. It is not the whole mass of the brain that concurs in this act. The whole nearly of the cerebrum may be removed successively, without impairing the faculty of perceiving impressions in animals. It is only when the portion of the medulla oblongata, near the seat of the tubercula quadrigemina is destroyed, that this faculty ceases to exist. To this point then, it may be

* See page 121.

concluded, must impressions be transmitted in order to be perceived.

The conducting or transmitting organ of the impressions or sensitive stimulations made on a sensitive surface to the brain, is nerve. This is clearly established by experiment. The brain and the sensitive organ may each be in the most perfect condition, and susceptible of experiencing sensitive impressions and perceptive actions, but, if the nerve that connects the two, be tied, or divided, no sensation can be experienced. To the accomplishment of sensation, the three organs or portions of the nervous system of the sensations, must be in a state of integrity; lesion of either will mar its production.

If the inquiry be made as to the manner in which impressions on, or irritations excited in the nervous expansions or tissues of the organs, and transmitted to, or repeated in the brain, produce the phenomenon of sensation, it must be frankly confessed, that no explanation can be given, or even attempted. Its production is one of the profoundest mysteries of nature, and the assertion will not be considered rash, which places it beyond the pale of human intelligence.

In what has been stated, the facts are appreciable, and open to observation and experiment. Here is the limit of our certain knowledge, and to step beyond it, would be to engage in the inextricable labyrinth of an endless hypothesis.

The phenomena of the sensations, or sensibility, investigated by experiments and with careful observation, authorize the establishment of the following series of general facts, formulæ, or laws.

1st. Sensibility is a function attached to certain organs or apparatus of the nervous system, and not a vital property, as is asserted by Richerand, and other physiologists.

2d. It is not consequently identical with irritability or organic force, and must not be confounded with it, as is done in most medical writings.

3d. The material organs of the sensations are, *a*, the nervous membranes, or expansions in the organs, as the retina in the eye, the expansion of the olfactory nerve on the Schneiderian membrane, &c.; *b*, the nervous cords, or nerves, that form the communication between the organs of the senses and the encephalon;

c, the posterior columns of the medulla spinalis, and nerves that are implanted in it; *d*, the large or ganglionic branch of the fifth nerve, and glosso-pharyngeal nerves; *e*, the medulla oblongata.

4th. The activity of this function, or the acuteness of the sensations, is always in proportion to the development of these organs.

5th. Integrity of each portion of the material organs, or apparatus, is indispensable for the production of sensation. Lesion of any one interferes, according to its extent, with its production. The converse is true, that every aberration of sensibility is an indication of a morbid condition of some portion of the apparatus, or organs of the sensations.

6th. In every sensation, the irritation or excitement produced by impressions in the nervous expansion or tissue of an organ of sense, is repeated in the encephalon to which it has been transmitted by the nerves that maintain the connexion between the two. The repetition of this irritation in the encephalon, causes perception in the intelligence, and thus constitutes the sensation.

7th. Sensation is different for each particular sense; it is not the same in the visual, as in the olfactory, gustatory, auditory, or tactile senses; in each of which it differs, and is excited by a different and peculiar stimulus.

The difference of the sensations is, in part at least, owing to the different structure and consequent modification of action of each nervous tissue in the organs of sense. The retina, the expansion of the olfactory, and auditory nerves, &c. are each one different in structure from the other, and have a different sensibility. The retina is sensible to the rays of light, the olfactory nervous tissue to odorous emanations, the auditory nervous tissue of the labyrinth to the vibrations of bodies, &c.

8th. The encephalon, deeply engaged in the performance of its own functional acts, is not susceptible of receiving or repeating feebler impressions transmitted from the organs of the senses, and consequently they are not perceived, and sensations are not experienced. Persons profoundly occupied in thought, are abstracted from exterior impressions, and are unconscious of the occurrences passing around them.

9th. The encephalon, when its actions become torpid, as in sleep, from the congestions induced by narcotics, or from com-

pression, either is incapable of repeating the stimulations excited in the organs of the senses, or they cannot awaken perception, and in this state of the brain sensations do not exist. The absence of positive pain is not then to be regarded as conclusive evidence, that a morbid lesion does not exist when the brain is in this condition.

10th. When a sensation of great intensity exists, and occupies the encephalon, another sensation cannot be perceived at the same time. The male frog, during the venereal orgasm, may be mutilated by the amputation of his legs, without inducing him to forego the embrace of his mate, or apparently to suffer pain. The Aphorism of Hippocrates is founded on this law: Ambo partes non possunt dolore simul. Duobus doloribus simul orientibus, vehementior obscurat alterum. Persons labouring under acute gastritis, or other intense internal inflammations, become insensible to tickling, though extremely sensitive to it in health. This law explains the obscurity that often involves the complications of diseased organs; those that are most intensely affected, suppressing the symptoms, or the expressions of disease in others, and which become manifest as the first decline in their force.

11th. Sensibility in its exercise, or the sensations, is exciting to the vascular system, and determines increase of the circulation, proportioned to the acuteness or activity of the sensations. Very acute sensations by this process establish frequently inflammations, or occasion congestions, even of fatal character.

12th. Sensibility is diminished or exhausted by its active and continued exercise. The more lively is its excitement, the more speedily does this state occur, and the longer is the period required for its reparation. From this law all the senses are intermittent in their action, and all sensations after a certain period subside and terminate. This effect is most probably a result of sanguine congestion produced by the stimulation of the sensations in the encephalon. Those unhappy sufferers, who are the victims of acutely painful diseases, are fully aware, that the period of temporary exemption approaches whenever the pains acquire their greatest intensity.

13th. Sensibility becomes more active, and the sensations more acute, when volition directs the action of the brain to, and concentrates it on the impressions or stimulations made on the sur-

faces of relation, or nervous tissue of the sensations in the organs. By dismissing as it were other operations, the repetition of the sensitive stimulations is more easily accomplished in the brain, and awaken a more distinct perception.

The sensations may accordingly be divided into active and passive: the first exist when the impressions excited by bodies are attentively examined under the direction of volition; the last, when the impressions are made on the surfaces of relation, or the organs of the senses; but the action of the brain being directed by volition to other objects, they are only faintly perceived, or escape attention.

14th. The sensations become more acute and delicate by frequent repetition, and the senses, acquiring a more perfect sensibility, are improved by frequent use or education. It is, however, the moderate exercise of the senses alone that produces their highest perfection. This maintains them in that healthful degree of excitement in which the structure is the most perfectly formed.

15th. Sensations of excessive violence, or the too long-continued excitement of the organs of sensibility, produce the loss of this function, or cause unnatural sensations, or which are not corresponding to the impressions received. These effects are most probably a consequence of a modification in the nervous tissue receiving the impressions, from the excitement into which they have been thrown.

16th. Sensibility becomes dull and blunted when the organs of the senses are not sufficiently exercised. Their state of quiescence, by the defect of healthy stimulation, and consequent depression of vascular excitement, reduces the nutritive action below its natural grade, the structure is degraded, and its sensibility is diminished or lost. Total inaction of a sense is often attended with atrophy of its nervous organs.

17th. The imperfection or loss of one sense, is generally compensated by an increased acuteness and refinement of some of the other senses. Individuals deprived of vision, have often the touch so exquisitely delicate, as to be able to distinguish colours by the touch, from the slight differences and inequalities on the surfaces of coloured bodies. Numerous instances are recorded that substantiate this principle, in regard to all the senses.

18th. Sensibility is diminished by development and activity of

the apparatus of the voluntary movements. The remark has been made in all periods, that those distinguish for active and powerful muscular exertions, as the athletes, are generally very deficient in sensibility. Those, on the contrary, who have feeble muscles, and are delicately formed, are endowed with acute sensibility.

19th. Females and children possess a more lively sensibility than males and adults. To this cause they are subject to be governed by their sensations and passions, which constitutes in them the fickleness and versatility of their characters. This acuteness of sensibility in females, gives them the strong disposition they manifest to hysteria, which is a morbid state of the sensations and affective faculties.

20th. Every sensation is attended with pleasure or pain, desire or aversion. There are none probably that are absolutely indifferent, at least as respects the sensations connected with the conservation of the individual, or the species. The aphorism may have some limitation in regard to the sensations resulting from the intellectual acts, by which ideas are created and combined; yet in these operations are to be perceived pleasurable or painful sensations, and some of the most exquisite and purest of our enjoyments are derived from the exercise of the intellectual functions. The affective or moral faculties, in their exercise are either pleasurable or painful, as love and hatred, joy and despair, &c.

21st. Pleasurable sensations consist in a moderate and regular exercise, or excitation of sensibility, by an object adapted to the organ of sense on which its impression is made; as a harmonious disposition of colours and waving lines convey pleasurable impressions through the sight; melody in musical sounds inspire the most agreeable sentiments through the organ of hearing; soft, smooth, and warm surfaces, communicate pleasure through the touch; savoury food, by the stimulation of the gustatory sense, impart a highly pleasurable sensation when the appetite is keen, &c. For the existence of pleasurable sensations, all the organs of the sense, that are its seat, must be in a healthy condition, and exercised in a natural manner.

22d. Painful sensations are caused by an excessive and irregular action of sensibility, or its too great excitement by objects having relations to the organs of the senses, but acting with too

much energy; or by objects that have no relation to the functions of the organs of the senses, and are detrimental to their functional acts by irritating them unnaturally. Strong contrasts in colours, and irregular and angular forms, leave unpleasant impressions on the eye; harsh, discordant sounds grate on the ear; rough, sharp bodies cause positive pain in feeling; mechanical irritants applied to the retina, and in the ear, excite the most acute and lancinating pains. Morbid irritation or inflammation developed in the organs of sensibility, independent of positive impressions, cause intense suffering from pain, as inflammation of the eye, ear, &c.

23d. Pleasurable sensations when excessive pass into painful sensations; and the impressions, from whence proceed pleasure, carried to excess, terminate in pain. However wide may appear the difference between these two sensations, they are intimately associated, and both proceed from the same kind of impressions, varying only in degree. Buffon has said, that pleasure is the commencement of pain, and pain, the extremity of pleasure. This is not a paradox; the assertion is founded in correct observation. The same impressions that, in one grade, are exquisitely pleasurable, in a higher grade, are exceedingly painful, and even create a morbid condition. Gentle titillation is a sensation that might merit, far beyond scratching, the appellation of "a royal pleasure;" yet when pushed to excess in tickling, not only is it painful, but may even excite convulsions. Pain is the morbid state of pleasure.

24th. By the production of pleasure and pain, sensibility executes its office in the economy. This office consists in the guidance and government of our actions, as conservative of the individual, and the species, and as sustaining our relations in social intercourse. These are the common end they are deputed to fulfil. The pleasure derived in satisfying our wants, invites and solicits us to gratify them: pain warns us of the presence of objects inimicable to our organs, and of actions of disorganizing tendency; and nature calls in its aid to enforce attention to the wants of the economy, and compel our efforts to satisfy them, when her milder solicitations prove unavailing.

Pleasure consisting in the natural and healthy excitement of the organs of sensibility, is the necessary consequence of a wise and prudent employment of the various functions of our eco-

nomy, it is the companion of health, and is incompatible with disease.

Pain resulting from an undue and unnatural excitement of the same organs, it inevitably follows on excesses and the abuses of our functions, and is the attendant of disease. Whenever there is pain, there is lesion.

Pleasure and pain are thus seen to compose the physical basis of morals.

25th. Pleasurable and painful sensations are always attended with excitement in the cerebral organs of the sensations, and when excessive, it may amount to a morbid degree. As a consequence of this principle, in all acute cerebral irritations and inflammations, painful remedies, as blisters, caustics, &c. should be avoided. They augment the mischief.

When irritations are transmitted to the brain, they are reflected through the agency of the nervous system into the whole of the organism.* Pain and pleasure are consequently capable of being employed as therapeutic agents with effect, and are also susceptible of provoking morbid disturbances. When these sensations are excessively acute or protracted, irritation is very commonly observed to succeed in the stomach, which holds so intimate an association with the brain.† This is evidenced by the loss of appetite, the impaired digestion, the foul tongue, the unpleasant taste in the mouth, and the sense of fulness and uneasiness in the epigastric region, that succeed to these sensations. Painful operations are very commonly followed by well-characterized gastric irritation, which is the most usual cause of what surgeons call sympathetic fever; and when a capital operation is performed while the patient is labouring under gastro-cerebral irritation, a severe, and often fatal attack of what is called typhoid or typhus fever ensues, the real origin of which is seldom suspected.

26th. When the brain is in a state of irritation, either sympathetically or idiopathetically, by the augmentation of sensibility, impressions that would, in a natural state of that organ, be agreeable, cease to be so, or even excite violent pain, and morbid sensations are experienced in different organs, without experiencing actual impressions.

* See page 34. † See page 42.

27th. The sudden cessation of severe pain is succeeded by pleasurable sensation. In parturition, the subsidence of the throes of labour, by the expulsion of the child, is accompanied with very lively pleasure. Women often exclaim, after deliverance, they feel as if in heaven.

28th. A feeble pleasurable sensation, diminishes the acuteness of a stronger painful sensation, and sometimes suspends it entirely. Frictions with the hand, or with soft, emollient, and warm applications, blunt the acute pains of colic, of rheumatism, and, occasionally, of neuralgia; and when they are not intense, frequently remove them.

29th. The irritation that produces a particular sensation on one part, will occasion a different sensation in another. I was consulted by a gentleman from North Carolina, who had for several years been affected with neuralgic pains of a most intense severity, which fluctuated between his feet and his head. When the feet were affected, the pain was most excruciating, but was unattended with swelling, heat, or redness. In an instant the affection would be transferred to the head, and the sensation was that of an immense mass of metal pressing on his head, but was not productive of acute pain.

§ 3. *Of the External Senses.*

The external senses in man are five, tact or touch, taste, smell, hearing, and sight. They will be treated of in a very cursory manner, and only in the circumstances that have a bearing on the establishment or the support of general principles, applicable to the theory and practice of medicine.

Sense of Tact or Touch.

The skin is the seat of this sense, and the papillæ are generally regarded as the portion of this structure, in which resides its immediate organ, or by which it is exercised.

By the sense of touch is acquired a knowledge of the form, consistency, state of the surface, volume and distance of bodies, and by which we judge of temperature. It is put into action by the absolute contact of exterior bodies, and the ideas it developes

in the mind, have been supposed to be more accurate and distinct than those derived from the other senses. It has even been named the geographical sense. It is questionable, whether touch does in reality possess so great a superiority over the other senses. It is not without its defects. The senses mutually aid each other; none alone is sufficient to communicate absolutely accurate ideas, which are formed by the united contribution of all the senses.

Tact is to be distinguished from touch, from which it differs in some respects. Tact is the sense of feeling possessed equally by every part of the skin, and internal mucous membranes, and is common to all animals; touch is limited to the hand, which may be looked upon as its organ, and to the lips, in which it is also very delicate. Tact is passive touch, while touch is active tact.

This sense acquires exquisite delicacy and acuteness in many individuals who are born blind. They are often capable of attaining to considerable excellence in the arts, and to distinguish colours, persons, &c. by the perfection to which it arrives.

Gentle frictions, with soft, smooth substances, or with the hand delicately applied, procure agreeable and pleasurable sensations, that exercise often a well-marked influence over the actions of the economy, and may be employed with decided advantage as a therapeutic resource. These effects are more especially experienced by those endowed with a lively sensibility. A mild and pleasing languor takes possession of the brain, and is diffused through the various organs; drowsiness is induced, the circulation is rendered more calm and tranquil, the skin becomes relaxed, warm and humid, and pains, and irritated feelings are assuaged and dissipated. The touching of a delicate and experienced hand will occasion voluptuous thrills, that pervade the whole frame. These are the effects that are attributed to animal magnetism; and when persons of lively sensibility abandon themselves unresistingly, and with full faith to the operations of the magnetizers, they manifest various phenomena emanating from the nervous system, and not unfrequently are cured of affections depending on its irregular actions.

When the brain is sympathetically irritated, or receives active stimulations from organs in a state of acute phlogosis, these agreeable sensations cannot be awakened through this sense; the impressions exciting them are no longer in harmony with the con-

dition of the perceptive organs of sensation, and are either unperceived, are suffocated by the morbid impressions, or their stimulation acts in the same direction with those of the disease, and increases the cerebral disturbance. In gastritis, enteritis, hepatitis, and all very acute internal inflammations, individuals, though exceedingly sensitive to titillation in health, lose their susceptibility to this feeling, or, if the act be persisted in, it provokes to passion, anger, and even violence. The return of this species of sensation, is an evidence of the convalescent state.

Impressions made by bodies that are rough and hard, excite disagreeable and painful sensations, producing aversion with attempts to escape from them. When these impressions are powerful and long-continued, they may terminate in the production of a morbid state of the brain, by establishing in it irritation; convulsions and apoplexy have been occasioned in this manner.

M. Broussais adopts as a principle, that tactile impressions, whether agreeable or painful, as well as all the external sensations, are never judged of by the centre of perception alone, and a priori; but are first reflected into the sensitive parts, and the viscera, which reflect them back again to the brain; and that this organ determines on those impressions according to their relation with, or mode of influencing the viscera, especially the epigastric centre.*

This complicate explanation we cannot look upon otherwise than as entirely gratuitous and hypothetical. The facts may be solved on a more simple and direct principle. It will not be contested, that tactile and other sensations are modified by visceral inflammations; but this arises from the morbid irritations irradiated from the inflamed organs to the brain, which being sympathetically disordered, the mode of its sensibility is changed, it can no longer respond, in a natural manner, to healthy and natural impressions, and the perversion and vitiation of the sensations result from the unnatural position of the central organs of the sensations, the integrity of which is essential to natural and regular phenomena.†

By embracing this principle of M. Broussais, it would necessi-

* Physiologie Appliquée a la Pathologie, t. 1, p. 61.

† See pages 136–137.

tate the admission of the doctrine, that the impressions of colorific rays on the retina, do not impart the ideas of colours, until they have been reflected to the epigastric centre, and are thence returned to the brain, which then determines on them, (that is, forms the ideas of colours,) according to the interior sensations they excite in the viscera. The same process is of course pursued, as it respects the ideas derived from the senses of taste, of smell, and of hearing. Few, however, are prepared to admit a doctrine of this nature, which places the brain and the intellectual faculties in a degrading dependancy on the organs of the mere nutritive functions.

This sense partakes of a pathological condition; and presents two opposite characters. The one is an extreme sensitiveness of touch. This state is seldom general; most usually it is partial. The slightest impressions, the mere weight of the hand, or the bed-clothes, are experienced as painful. I have seen this state to occur in fevers, and in a case of colitis, terminating in ulceration. It is a symptom of irritation or slight inflammation of the anterior columns of the spinal marrow.

An aberration precisely the reverse is sometimes experienced, which is the entire loss of the sense. Dissection has shown this to arise from lesions of the spinal marrow, implicating its anterior columns.

Sense of Taste.

By this sense is obtained ideas of the sapidness or taste of substances. Placed at the commencement of the digestive organs, it acts as a sentinel warning of the quality of our food, as possessing salutary or noxious properties.

The organ, or the seat of this sense, is the tongue; and the sense is most acute at the tip, but exists on the sides and the inferior surface; it is also possessed by the palate.

The liquid state is indispensable for the production of this sensation; substances wholly insoluble are entirely tasteless.

In analyzing the sensations proceeding from substances placed in the mouth, they are found to be of different kinds. They are, 1st, those of simple tact; 2d, of taste; and 3d, of smell; and these are frequently united in the same substance.

When the application of an insoluble substance is made to the

tongue, as a diamond or topaz, the sensation is that of tact alone. If an insoluble, but odorous body is employed, the odour passes through the posterior nares, and makes an impression on the nerves of smell, which is often mistaken for taste; this occurs with tin. By closing the nostrils, so as to prevent the odour from passing through them, the taste, as it is supposed to be, disappears. Other matters, as salt and sugar, affect the sensations of touch and taste; and finally, some substances at once excite the three sensations, of touch, taste and smell; such are savoury meats, soups, spices, &c.

Several nerves are appropriated to the organ of taste, and some doubt and obscurity prevails as to the one by which this function is performed. The following nerves are distributed to the tongue: 1st, the ninth pair, which are muscular nerves; 2d, the third branch of the fifth, which is expended on its mucous covering and the salivary glands; and third, the glosso-pharyngeal, which is distributed on the surface of the root of the tongue.

The first of these, or the ninth, bestows on the tongue voluntary movement. The division of these nerves paralyses this organ, while the sensation remains unaffected. The third branch of the fifth is generally regarded as being the nerve of taste, and is named gustatory. It must be confessed that this point is not completely determined. The other branches of the fifth are nerves of tactile sensation, and are necessary to enable the organs, and even nerves of the senses, to be sensible to impressions; and it is not in the order of nature to give to a single branch a totally different function and different powers from those of the trunk. It has been suggested, that the last, or the glosso-pharyngeal, was the true gustatory nerve.

This sense frequently manifests unnatural phenomena as an effect of disease, which are then symptoms. Most commonly this species of aberration depends on the state of the mucous membrane of the tongue and its secretions, which are morbidly affected in numerous diseases. In most gastric irritations the taste is more or less deranged, and in very acute inflammations it is entirely lost. In some nervous affections this sense is strangely perverted; the most loathsome and disgusting matters exciting a lively relish. In some instances it is entirely absent, from a defect in its nervous organs.

Sense of Smell.

This sense is put in action by the odorous particles or molecules that escape incessantly from particular substances. The air dissolving these particles, is the medium by which they are brought to influence the nerves of this sense, as it is inhaled into the nostrils.

The sense of smell, like that of taste, is placed as a guard over the avenue leading to the interior of the economy, to give warning of the presence of odorous bodies, and instruction as to their innocent, wholesome, or noxious properties. In these respects this sense is much less perfect in man than in many of the inferior animals, but is more to be relied on, and executes more efficiently this duty than taste.

The mucous tissue lining the nasal fossæ, named the Schneiderian membrane, is the seat or organ of this sense. All portions of it, however, are not in possession of this faculty; the superior part alone claims this distinction, while the rest enjoys the sense of tact in an eminent degree.

Two nerves are distributed to this membrane, the first or olfactory nerve, the filaments of which are spread over the outer surface of the superior turbinated bone, and the septum of the nose; and some branches of the fifth pair. To the first was uniformly conceded the function of smell, until Magendie was induced to doubt the accuracy of this generally admitted fact, in consequence of some experiments he performed, and was led to transfer that office to the fifth.

By dividing the fifth pair in animals, in the cavity of the cranium, Magendie found that the impressions made by certain powerful and irritating emanations, as caustic ammonia, Dippel's oil, and acetic acid, were not perceived, or did not produce sensation, although the first pair or olfactory nerves, remained entire. Hence he too hastily inferred, that the fifth, and not the first, was the true olfactory nerve. He observed, however, that a dog, in which the fifth pair was divided, could distinguish meat wrapped up in paper, which he would unfold to obtain the food.

The fifth pair of nerves belong to tactile sensation, and it would

appear from these, and other experiments of Magendie, that the olfactory, optic, and gustatory nervous tissues, require this species of sensation to be enabled to receive impressions. Those senses are put in action by the direct impression of their respective irritants or stimulants, as odours for the olfactory nerve, rays of light for the retina, &c. and consequently must possess the sense of touch to be sensible to their impression. The fifth nerve communicates this sensibility, and when it is divided, the sensibility of the retina and olfactory nervous tissue is lost, and the impressions of irritants are no longer experienced. This appears to be the true explanation of the destruction of the functions of those senses, when the fifth nerve is divided in experiments or disorganized in disease; and such is the manner in which this nerve concurs in the production of the phenomena of those senses.

From the sensibility imparted by the fifth pair of nerves, irritating impressions cause sneezing, and the uneasiness they produce lead to blowing the nose for their removal. By this means this sense is defended from those injurious influences that might injure it.

The impressions on this sense have a very decided effect over important organs of the economy. The brain is evidently excited by strong odours and stimulation of this sense. Rousseau, from this circumstance, called smelling the sense of the imagination.

In asphyxia, and in lipothymia, the respiratory apparatus is very effectively excited into action by strong irritating effluvia, and the suspended process of respiration is restored.

The stomach is also agreeably stimulated by particular savoury smells that awaken the appetite, while it turns from other odours with loathing and disgust.

The genital system is not exempted from the influence of the olfactory sense. Many odours it is well known awaken erotic excitement. This circumstance is of more marked and frequent occurrence in animals, who are more under the government of the senses, than in man.

This sense attains to great delicacy by exercise, as is seen with those who are engaged in the trade of perfumes; and, on a late trial in London, it was given in evidence, that the dealers in human hair in that city, were accustomed to distinguish, by the

smell, to what nation the individuals belonged from whom it had been taken.

The sense of smell is subject to morbid lesions arising from various causes, and from which the practitioner obtains important aid in establishing a diagnosis and prognosis. The deviations from a natural state are, great acuteness, abolition, and perversion. The first, when suddenly displayed, often precedes and announces the attack of cerebral inflammation; it occurs in the commencement of some fevers, and attends often on nervous irritations.

The loss of this sense is occasioned by inflammation of the gastro-intestinal mucous membrane, exciting irritation, and suppression of the secretion of the Schneiderian membrane, or by whatever produces an arid condition of that tissue. It also arises from local diseases that carry a lesion into the structure or function of the olfactory, or of the fifth pair of nerves.

The perversion of this sense occurs in chronic inflammation of the digestive mucous membrane, and in the close of some fevers. The patient is annoyed with the perception of putrid and fetid odours, which do not really taint the air. It is a fatal sign.

Sense of Hearing.

Sound is the sensation of which a knowledge is acquired by the sense of hearing. Sound consists in the impulses or vibrations communicated to, and repeated by the different layers of air composing the atmosphere, and which proceed from similar vibrations or impulses produced in solid bodies, or other substances. These vibrations extend to certain distances, and when they reach the interior of the ear, or organ of hearing, they cause a sensation designated as sound.

In this sense, the impression received by the nerve, is not, as in the exercise of the preceding senses, the immediate effect of the direct impingement, or absolute contact of the exciting body, but proceeds from it indirectly through the movements it gives origin to in the atmosphere, and which are transmitted to the auditory nerve through the tissues by which it is enclosed and surrounded.

The organ of hearing is the ear; the essential portions of which

are cavities situated in the petrous processes of the ossa temporum. It is a complex instrument constructed on acoustic principles. The pavilion or concha collects the sonorous vibrations, and directs them into the meatus auditorius; they are received on the membrana tympani, which divides the middle cavity of the ear or tympanum from this canal. This cavity contains air which reaches it through the Eustachian tube, opening into the posterior nares; it also communicates with numerous small cells contained in the mastoid process. In this cavity are situated four small bones, the stapes, malleus, os orbiculare and the incus. The first is attached to the membrana tympani, and the last to a membrane closing a communicating opening from the tympanum into the labyrinth, the fenestra ovale.

These bones, articulated together, form an angular lever extending from the one membrane to the other. They are moved by four small muscles, and by their movements give greater or less tension to the membranes to which they are attached.

The precise objects accomplished by these ossicula is not well determined, though it is most generally supposed the modulation sounds undergo, is accomplished by their action. Their loss, with the exception of the stapes, does not appear, however, materially to affect this sense.

The most important portion of this structure is the labyrinth, which is divided into three cavities, cochlea, semicircular canals, and vestibule. These cavities are lined with a very delicate membrane, the character of which is not positively determined, and they are filled with a pellucid fluid, called the liquor Cotunnii. The portio mollis of the seventh nerve or the acoustic nerve, is distributed on this membrane of the labyrinth, and filaments of it float loosely in the liquor it secretes. This membrane is of a texture so exceedingly delicate, anatomists have not been able to investigate it in a satisfactory manner.

The natural condition of the labyrinth is the essential requisite for the exercise of this sense. The other portions of the structure may be imperfect, and even destroyed, yet the capacity for hearing continues, and the sensation of sound may be produced by vibrations transmitted through the medium of the bones of the cranium to the auditory nerve. In cases of deafness, it may be determined, by putting a watch in the mouth, and resting it on

the teeth, or by holding a tuning-hammer on the teeth, whether the disease proceeds from a defect in the labyrinth and nervous organs, which is generally incurable, or depends on an obstruction in the avenues leading to it. In the first case, the ticking of the watch, and the sound of the instrument will not be perceived; in the last the sounds from them may be discerned.

The nerves that pass to the organ of hearing, are the portio mollis of the seventh pair, which is expended in the labyrinth, and is undoubtedly the auditory nerve; a branch of the portio dura of the seventh, which is a nerve of muscular movements, and is destined to the muscles of the ossicula; and a branch of the second division of the fifth or the Vidian nerve, and which is a nerve of tactile sensation or of feeling.

In the production of hearing the accessory parts collect, condense, and conduct the vibrations or undulations of the air, put in motion by sonorous bodies, to the auditory nerve floating in the liquor of the labyrinth, and existing in its membrane. The impressions, or the excitement thus produced in the nerve, are transmitted to the encephalon, and being perceived by the intelligence, ideas of sound are acquired in its various modifications of noise, speech, singing, music, &c. which are varieties of the same phenomenon.

The clearness and distinctness of the sensations, proceeding from sonorous oscillations, are not similar in all individuals, or as caused by all bodies. In some they are much more acute than in others, and they vary infinitely as to the objects which have produced the vibrations.

The ideas derived from sound are different, and all individuals are not capable of receiving and expressing them equally alike. This does not depend on any difference in the acuteness of the sense, but would appear to depend on the cerebral faculties, in which the perception and appreciation of the sensation resides. Proportionate or harmonious sounds convey to many, ideas with so much distinctness, they are enabled to impart them to others with similar capacity, and even to express them in characters. This is the origin of music, and those alone, who possess the organs or faculties that perceive this kind of sounds, can be musicians, or even comprehend the composition of a piece of music. Their sense of hearing is not in fault; it is equally acute, equally

delicate with that of those who understand and enjoy musical compositions, and their defect can be attributed to no other cause, than a deficiency in the perceptive and judging faculties.

To these individuals music possesses no other character than that of noise, and may be agreeable or disagreeable, but they can never acquire a knowledge of those fine shades of difference constituting tone; nor the slightest comprehension of the mathematical relation that sounds bear to each other.

The sense of hearing is essential to speech, and all individuals are capable of speech who possess hearing, as all are endowed with the perceptive organs of language. Hearing is the guide that directs the movements of the tongue, lips, fauces, &c. by which the modifications of sound, called speech, are produced. All who are unfortunately born with defective organs of hearing, or which become injured early in life, are incapable of speech, and remain dumb.

That it may be clearly distinguished, sound must not be too loud, or sink too low. When it is too loud, the impressions are confused, are beyond the mode of action of the nerve, and the perception of them is indefinite; when too low, they are indistinct.

Sounds of great intensity, by the violence of the impulse communicated to the delicate structure of the ear, frequently injure it, and destroy hearing. This circumstance has repeatedly occurred to cannoneers serving heavy artillery during the sieges of fortified places.

The impressions on this sense are experienced in other organs of the economy. It is well known, that certain sounds cause an unpleasant sensation in the teeth, and others are accused of giving a disposition to evacuate the bladder.

No one can contest the power this sense is capable of exercising over the moral or pathetic faculties. All the passions and emotions of the soul are at its command, and are called forth at the will of a skilful performer, by the magic sway of musical sounds. Music was at times employed by the Greek physicians as a therapeutic resource, and it is probably too much neglected in modern practice.

The excitement occasioned by certain sounds, such as are loud, shrill, and piercing, is exceedingly distressing to those who are

affected with cerebral excitement, or suffer under nervous irritation, and may cause aggravation of the disease. I once witnessed in a patient, in the Pennsylvania Hospital, subject to paroxysms of mania, and who had been a military officer, a violent attack brought on while walking calmly in the yard, by the sound of a trumpet, which was blown as a troop of horse was passing. He seized a stick, addressed a tree as Napoleon, and commenced a furious assault.

Plaintive and melodious sounds are tranquilizing, and often allay nervous irritation. I attended a gentleman from Virginia, who was an amateur of music, and a very fine performer on the flute, in an attack of pneumonia. Being absent from home, he became very much depressed in spirits during his convalescence, and his nervous system was exceedingly irritable, particularly in the night, when he was restless and could not sleep. I became apprehensive of nostalgia. While in this state, some pleasing melodies were accidentally performed under his window on a hand-organ, with which he was much delighted. His mind was immediately composed, and he engaged the man to continue his performance; he obtained a quiet night with comfortable sleep. He repeated the experiment with a similar result, and soon recovered.

This sense is subject to be variously affected in disease. Slight derangements in the accessory portions of the structure diminish often the distinctness and accuracy of the impression, and the sense is made to appear imperfect. Too great flatness of the concha, by not directing the sounds into the meatus, will have this effect.

The membrane lining the meatus, secretes a waxy matter, which is sometimes indurated, and blocks up this avenue. At other times it is not secreted, and the too great dryness of this passage causes a confusion in the vibratory impulses of the air, as transmitted through it. These opposite conditions are equally causes of hardness of hearing.

The free communication of the tympanum through the Eustachian tube with the external air, is a positive requisite that the air contained in it, may continue the vibrations that impinge on the membrana tympani, and thus be communicated to the liquor of the labyrinth. The occlusion of this tube is consequently a

cause of deafness, and which is cured by perforating the membrane of the tympanum, as proposed by Sir A. Cooper.

Inflammation of the organs of the ear is a common result of exposure to cold, and is accompanied with excruciating pain. It sometimes occurs that the inflammation extends into the mastoid cells, brings on caries of the osseous structure, and is the source of great distress, and frequently of great danger to the patient, by involving the coverings of the brain, or the brain itself. It has from this cause produced all the symptoms of cerebral inflammation, and in some cases of malignant intermittents.

Deafness, when it succeeds to diseases of the brain, or its membranes, as hydrocephalus, apoplexy, &c. proceeds generally from lesion in the nervous organs of this sense, and is irremediable.

This sense is affected as a symptom in diseases. It is frequently excessively acute. This occurs in cerebral irritations, in the first stages of fever, &c. It is diminished in its acuteness as fevers advance into the typhoid or adynamic character, but is not an unfavourable sign.

Perversion or vitiation of this sense is not unusual; the patient is then annoyed with the perception of sounds that have no real existence, as the ringing of bells, tinkling of metallic sounds, sound of beating, of the wind, of the rushing of water, burring, &c. These are to be taken as signs of cerebral excitement.

Sense of Sight.

The organs of this sense, like those of hearing, are a complex apparatus, including an instrument constructed on physical principles combined with instruments acting on organic or vital principles.

This apparatus consists of the eye, a dioptrical instrument, the optic nerve, and tubercula quadrigemina, which are portions of the medulla oblongata.

By the exercise of this sense are acquired the ideas of colour, figure, and probably of the distance and magnitude of bodies.

The immediate agent exciting visual impressions is light, the specific stimulus of the optic nervous sensibility. Bodies are visible only because they reflect to the eye a part of the rays of light they receive. This matter possesses extreme subtleness, and emanates from bodies that are luminous, as the sun, &c. It moves

with inconceivable velocity, and, in parting from bodies, it forms diverging cones, moving always in a direct line. It is susceptible of refraction in passing from one medium to another, and of reflection, when the angle formed by the reflected ray is equal to that of its incidence.

Light is a compound matter, having various properties, and is productive of varied effects. Its particles possess very different temperatures; some rays raising the thermometer more than others; and they are gifted with the power of causing chemical actions of different kinds. Its effects in this way, render it a conspicuous agent in the operation of chemical phenomena. It is susceptible of decomposition, by which means the preceding facts are determined; and it may further be separated into different colorific rays, each of which excite a specific impression on the retina, and thus imparts the sensation and perception of particular colours.

A short exposition of the organs concerned in vision will be required to comprehend its mechanism, and the various causes that interfere with the natural exercise of this sense, or totally destroy it.

The eye, which is the physical instrument of vision, is composed of several distinct portions, the design of which is different. 1st, It contains a series of transparent, refracting media, that dispose the rays of light in a certain order; these are the cornea, aqueous humour, lens, and vitreous humour. 2d, Means are provided to regulate the introduction of light, and to absorb or neutralize it after it has accomplished its purposes in vision. 3d, It possesses a nervoso-vascular tissue or membrane, the retina, analogous in its structure to the cerebral medullary substance: this is commonly supposed to be an expansion of the optic nerve, but there is a marked difference between the structure of the two. 4th, It has a special case, called the sclerotic coat, which contains and supports the preceding parts.

To adapt this instrument to the complete and entire performance of its offices, an accessory apparatus was required and is provided; 1st, the socket which protects the eye from external violence; 2d, the muscles that move the globe of the eye, and place it in the line of vision of different objects; 3d, the prolongations of the skin forming the eyelids, which are moveable curtains for the protec-

tion of the anterior face of the eye, exclude, or admit the light at will, and defend the eye in sleep; by their constant movements they spread over the eye the moisture of the tears, which they conduct along the triangular canal, formed by their edges, to the excretory ducts leading to the nostrils; 4th, the eyelashes arrest the floating dust and atoms diffused in the atmosphere, which would otherwise irritate and inflame the eye; 5th, the eyebrows serve to absorb redundant light, and shelter the eye from the sweat that would trickle from the forehead into it; and 6th, the lachrymal glands that secrete the tears, maintaining the humidity and the transparency of the cornea by which the pencils of light penetrate the chambers of the eye, and which dilute and wash away offending matters that become applied to the conjunctiva.

Of the accessory parts, the eyelids and the tears are the most important in the preservation of vision. The extirpation of the eyelids is always productive of a destructive and mortal ophthalmia. The loss of the tears prevents the movement of the eye between its lids, and from the adherence of foreign matters on its surface a fatal inflammation results.

The globe of the eye is the organ in which the acts of vision properly occur; it contains the dioptrical apparatus by which the luminous rays are conducted and concentrated on the nervous tissue, which is spread on its posterior internal surface, and on which the sensitive impression is received.

From every visible point diverging rays of light emanate; a portion of which fall on the cornea, forming a cone, of which the cornea is the base; after penetrating the cornea they reach the retina, passing through the aqueous humour, the lens and vitreous humour, which refract all the rays that are not in a direct line with the optic axis, and thus a second cone is formed, whose summit is at the retina, and whose base, opposed to that of the first, is at the pupil. The first cone, without the eye, is called the objective cone; the second, within the eye, is called the ocular cone. This disposition occurs with every fasciculus, or bundle of rays, that proceed from the superior, inferior and intermediate points of the surface of a visible body. But the cones that are projected from the superior points, are united on the retina, be-

low the spot where falls the cone from the centre; and the cones that emanate from the inferior points, on the contrary, fall on the retina, above the point occupied by the cones in the axis of the eye.

By this disposition the various luminous cones that are projected by all the points of a visible surface of an object, cross each other at a point in the crystalline lens, called the optic centre of the crystalline, and form an outline or image of that object on the retina, but in a reversed position.

Two conditions are essential that the visual impression on the retina should produce the vision of an object; 1st, a sufficient extent of the retina must be occupied by it, so that the different points may be appreciated; 2d, the impression should be distinct, that is, the luminous cones of rays should rest their summits immediately on the retina. These conditions vary according to the size of the body seen, and its distance from the eye.

When bodies are exceedingly minute, the eye cannot perceive them—the rays they project are faint, and occupy too small a space of the retina to make a sensible impression. This defect is remedied by art in the construction of instruments called microscopes.

If bodies are too near, the divergency of the rays proceeding from them is so great, the refracting powers of the eye cannot bring their forms on the retina, but which is thrown beyond it.

When they are too remote bodies cease to be seen. This arises from the absorption of the rays of light coming from them in the long course they traverse. The distance may also produce so feeble an impression, it ceases to be perceptible. The distance at which bodies are seen, varies with individuals. It depends on the sensibility of the retina, and the colour of the object.

Between the most remote and nearest points of distinct vision, there are numerous other points in all which vision is perfect. The eye must be modified in some manner to accomplish this end of distinct vision, in so many thousand points of very different distances. Many efforts have been made to give a solution of the manner in which this modification is accomplished. None yet proposed are free from strong objections. It most probably depends on the iris.

The distance of distinct vision varies greatly in individuals. The differences in this respect may be included between two extremes, that constitute myopy and presbyopy.

In myopy the visual point or distance from the eye, in which vision is most distinct, is approximated to the eye: objects can be seen only when they are approached very close to it. This state of vision is induced by various causes affecting the organ of sight; 1st, the eye may possess too strong a refracting power, or be deficient in its depth; 2d, the cornea and crystalline may be too convex, and the humours are too dense; 3d, or the retina is not of a sufficient distance from the lens. In consequence of these defects, the visual focus of the rays from remote bodies is formed in the vitreous humour before arriving at the retina, and the objects are not seen. This cause of defective vision is very common in early age, and is rectified by the changes induced by advanced life. To obviate it, concave glasses that separate the rays are to be employed.

Presbyopy is the reverse of the preceding. The visual point is more removed from the eye than natural, and bodies can be perceived only when remote from it. The organization of the eye is directly the opposite of that producing myopy. The refractive power is too feeble, or the retina too distant from the crystalline lens, and objects that are near the eye are not seen, because the point, where the rays proceeding from them unite in a focus, is beyond the retina. This defect occurs in the aged, and augments with age, which always enfeebles the refractive powers of the eye. Convex glasses are required to remedy this defect of vision.

In some individuals both these states of vision exist One eye being myopic, the other presbyopic.

In the mechanism of vision it is thus seen, that the apparatus of the globe of the eye is that of a dioptrical instrument, more perfect than any that has been invented by art. The end of this arrangement is to collect the divergent rays, projected by visual bodies, into foci or points, on the retina, the nervous tissue of the eye, on which stimulations or impressions are developed by the contact of luminous rays. Here commences the vital part of the phenomena of vision, and those terminate that are connected with physics.

The organic structure in which the vital phenomena of vision are seated, are the retina, the optic nerves, and the tubercula quadrigemina.

The retina lines the choroid coat, and is a soft, thin, pulpy, nearly transparent membrane. It embraces, on its inner or concave surface, the vitreous humour, but does not adhere to it. Behind it receives, or is connected with the optic nerve. Exterior to the point of junction of the optic nerve, and about a line distant from it, in the direction of the axis of the eye, is a yellowish spot, called the yellow spot of Sœmmering. This spot does not exist in the retina of all animals, but only in man, some quadrumana, and lizards. Being directly in the axis of the eye, the images or impressions of luminous rays are received on it; and small as it is, it has a degree of magnitude sufficient to admit nearly all the images that are thrown on the retina.

The retina is constituted of vessels derived from the central artery of Zinn, placed in the centre of the optic nerve, and of nervous matter. It is generally considered as an expansion of the optic nerve. M. Ribes regards it as a particular membrane to which the optic nerve is distributed, and thus makes it analogous to other membranes. I am disposed to consider the retina as nervous membrane or tissue, independent of the optic nerve, which is only in junction, or connected with it. The difference between the two appears too great to authorize us to look on the retina, as the mere expansion of the fibres of the optic nerve.

The optic nerve lying between the retina and the brain, is the medium of connexion between them. The optic nerves were formerly believed to terminate in, or proceed from the thalami optici. Gall has, however, shown this is an error, and that they really come from the anterior pair of the tubercula quadrigemina. They receive also fibres from the corpus geniculatum externum, and from a mass of gray substance, called tuber cinereum. Over the sella turcica of the sphenoid, the optic nerves are in apposition or junction with each other. It is a subject yet undetermined, on which different opinions continue to exist, whether the optic nerves decussate, are joined and confounded together, or are in mere approximation at this point. Comparative anatomy and pathological observations may be appealed to in support of either doctrine.

In the nervous division of the mechanism of vision, the impression made by luminous rays on the retina are transmitted along the optic nerve, and are received by the anterior pair of the tubercula quadrigemina. The sensation constituting vision, is then produced, but in a manner utterly inexplicable, and in fact, incomprehensible by our limited intelligence. What we know as certain is, that the integrity of these parts is essential for vision to exist. Lesion in either occasions its loss.

From the function of vision is derived our knowledge of the forms and colours of bodies. It is doubtful whether alone, unaided by the other senses, it informs us of their distances and magnitudes. From the relation of Chesselden, as to the first impressions after couching, on a person either born blind, or who had no remembrance of having ever seen, it might be inferred, that, in the first instance, visual objects appear as though directly applied to the eye, and it is only through the sense of touch, correcting the errors of vision, we acquire a knowledge of the distances and magnitude of bodies.

Another circumstance has engaged the attention of opticians and physiologists to explain. It is the fact, that the images of visual objects, painted on the retina, are reversed. How, then, does it happen, they are seen to be in their true position? Buffon and Lecat conjectured, that, primitively bodies are seen reversed, but that touch undeceives us in this respect, and by habit and education we learn to see them in their proper position.

Gall, opposing all the solutions that have been attempted, denies the necessity of making it a question for examination. He considers it an abuse of the physical phenomena of vision, applied to the vital or organic part of the function. Vision is not the consequence of the figure of visual objects being painted on the retina, but of the action, the impression excited in it by the rays of light, which, arriving through transparent media, form on it, as an accident only, an image of the object seen. Visible bodies to be seen, no more require to be painted on the retina, than do sapid bodies on the tongue, odours on the nostrils, &c. The mode of production of the sensations is the same in all the senses. In the case related by Chesselden, no distinction was at first made between sight and touch.

A discussion has arisen on another point of vision, in which

physiologists are widely different in their views. Vision is performed by two organs, two impressions are received, yet, in common circumstances, but one object is perceived. Various solutions have been offered of this difficulty, but none are entirely satisfactory. Gall cuts the knot by denying that two impressions are made. He contends that in active vision one eye alone is employed. Lecat had previously announced the same idea, and asserted that the right eye is employed in vision. This explanation is not admissible. When the eye is uncovered, the rays of light must enter its chambers, and reach the retina, on which it will of consequence make an impression, and an object be thus formed on each retina, though there be the perception of only a single object.

No explanation of this remarkable phenomenon, yet offered, can be regarded as satisfactory, or is exempted from numerous forcible objections that may be opposed to it. In all the speculations on this subject, the encephalic organs, in which terminate the series of impressions or movements constituting this sense, have been entirely overlooked: yet it is more than probable, that in them resides the real cause of this singular circumstance. What has led me to this conjecture, and which seems to confirm it, is, that in affections of the brain, vision is frequently double, though the eyes remain in their usual and natural state; and the phenomenon can be attributed to no other of the visual organs, than those located in the brain.

The facts I have observed in my own vision, will probably throw some light on this subject. Vision is different in each of my eyes; that of the left is myopic, that of the right approaches to presbyopy. When I place myself at a window facing the south, and look towards the south-west, with the shutter in a position to interrupt the sight towards the west, the left, or myopic eye is that which first receives the rays of light proceeding from objects moving from the west towards the east, or, in other words, first perceives them as they clear the obstruction of the shutter; and it is the last that receives the rays of light from objects passing from the east to the west when interrupted by the image of the shutter. Now, I invariably remark, that when objects approach from the westward, I first perceive a faint, indistinct image, corresponding to the vision of the left or myopic

eye, which, in an instant, is succeeded by a well-defined, distinct image, answering to the vision of the right eye. The reverse occurs with objects receding from me, or passing westward, the distinct image of my common vision disappears, and an indistinct image remains for an instant after it, which is the confused impression on the retina of the left or myopic eye.

My vision, both for distant objects and those approximated to me, is perfect; and without examination, I should never have suspected a defect in either organ of sight. When reading, which I commonly do at the focal distance of six inches, if I close the right eye, the letters continue perfectly distinct, and the vision is clear, but if I shut the left eye, I can perceive nothing but confused, interrupted, black lines, and to obtain distinct sight, I am compelled to remove the book to the distance of twelve inches from the eye. In reading, it is consequently the left eye alone that excites perceptive impressions.

The reverse of this prevails in distant vision. When I am looking at remote objects, and close my left eye, my vision continues perfect as before; I see distinctly; but if I shut the right eye and look with the left, I can perceive no object clearly beyond the distance of twelve or fifteen inches. Distant vision is of course entirely performed by the right eye.

From these observations the following inferences are deducible; 1st, that vision may be perfect, notwithstanding each organ of vision may be defective, provided those defects are not similar, and are limited solely to the focal distance; 2d, that vision proceeds from impressions on one eye when both are apparently engaged in its production; and 3d, that the strongest impression on the retina is alone perceived, and which may proceed alternately from the one or the other eye, according to the focal distance of distinct vision.

Several years past I was subjected to great personal and mental exertion, accompanied with anxiety of mind. My nervous system became considerably affected, and amongst other symptoms that came on, was double vision. I had constantly before me a strong distinct image, which was the vision of the right eye; and a confused indistinct image, lateral to the first, and which proceeded from the impressions on the retina of the left eye. This state of my vision was so unpleasant, especially in walking, I

was forced to limit my sight to the one eye, by wearing a shade over the left. It continued nearly four months. I have experienced temporary returns in the summer season, during very warm weather, and when exercising in the sun. Whilst affected in this manner, no alteration was perceptible in the axis of either eye, and the doubleness of sight appeared to depend solely on the central nervous organs in the encephalon, in which had been developed, prolonged excitement and congestion.

The axis of the eye, or the yellow spot of Sœmmering, is the point of most distinct vision, and when the eyes are directed to an object, the cones of light reflected from it always fall on corresponding points of each retina. In this case vision is always single; but if the figure of one eye be distorted, so as to change its natural axis, as by pressing on it; or the eyes do not correspond in their movements, as in the inebriated and in voluntary squinting, when the pencils of luminous rays do not fall on corresponding points of each retina, objects are, then, seen to be doubled.

Some phenomena connected with the action of the retina, are manifested in the perception of colours, that merit attention. If the eyes be directed, after looking intently on a coloured object, to a white surface, a spectrum is seen having the form of that object, but of a different colour. The second is called the accidental colour of the first, and usually holds a fixed relation to an original colour, but is always much fainter, than when proceeding from the actual excitement of coloured rays. Thus, after looking at red, the spectrum and accidental colour will be a very faint blue mixed with green; after orange, blue mixed with indigo; after yellow, indigo with violet; after green, violet with a tinge of red. White and black are accidental colours to each other; for, after looking at black, a white surface appears still whiter; and after looking at white, black is deepened in its intensity.

This phenomenon, most probably, depends on the continuance of the stimulation excited by the impressions of the coloured rays after they are withdrawn, though in diminished force. The perception of colours proceeds from the power possessed by colorific rays to cause movements in the retina, and each colour must have the capacity to excite specific movements. When the retina has been stimulated by any one colour for a certain time, and with a

certain energy, its movements do not instantly subside on the cessation of the stimulation, but gradually decline, and the movements of less intensity, which then ensue, give the perceptions of other tints. The accidental colours are always those that are of inferior exciting powers to the original colour.

This explanation of the preceding phenomena receives confirmation from another singular circumstance to be remarked in vision, which is, that different colours on the same surface, will produce the perception of an intermediate colour; for instance, small black spots, or small black print, on a red ground, appear green. The retina is actively and extensively stimulated in a specific mode by the red rays in the points on which they fall, and this awakens the perception of red colour; the points of the retina that receive no rays, (none being reflected from the black spots,) whence is imparted the sense of blackness, suffer partially the movements excited by the red rays in the surrounding parts, and which extend into them; and this feebler action of the retina in those points occasions the same perception as would have occurred from the actual impression of green rays, which are less stimulant than red, and excite a lower degree of action.

That vision may be distinct, the retina must receive only a certain degree of impression or stimulation, which has a limited range. Above or below that range vision ceases to be clear. When lights are too brilliant, and colours too glaring, the retina is over-stimulated, its movements are confused, and objects are seen imperfectly; it is called dazzling: when the light is too feeble, the retina is not sufficiently impressed to produce distinct movements, and objects are with difficulty discerned, or are entirely obscured.

The sudden passage from a very clear to a dull light, as going from the sunshine into a darkened room, renders the retina insusceptible for a short time to impressions; it is a temporary blindness. Highly stimulated in the first instance, this nervous tissue cannot experience the fainter impressions in the second, until its movements have subsided to a level with those impressions.

Exposed for a considerable period to either of the foregoing conditions—a dazzling light or a profound obscurity—the retina is deteriorated, and vision is impaired or completely destroyed. In

the first case, the excessive stimulation brings on sanguine irritation with change of structure in the retina; in the last case, the want of the exercise of function leads to a state of asthenia and atrophy of the organ.

That vision may confer its full extent of usefulness, the eye must be capable of various movements; and for which purpose it is provided with different muscles. The movements these muscles bestow on the eyeball, place its axis in the direction of the objects of vision; they guard it from injury by withdrawing its surface from hurtful impressions, or by removing matters that would otherwise prove irritating.

Besides the voluntary motions impressed on the eyeball in vision, it executes involuntary movements, which were first indicated by Mr. Charles Bell, by whom their objects were examined and described.

When the eyelids close, the eyeball executes a movement upwards, so as to place the cornea beneath the upper eyelid. This motion is seen in holding the eyelids apart, and then making an effort to close them; the eyeball will be seen to roll upwards. This motion occurs in winking, though it is so rapidly performed as to have escaped observation. The object of this movement is twofold; 1st, it carries the anterior face of the eye under the lachrymal gland, the secretion of which is thus diffused over it, and at the same time, any matters that should accidentally have been lodged on it are removed.

Mr. Bell further asserts, that this upward and outward motion takes place in sleep, by which the cornea is lodged in a secure position under the upper lid, and is kept moistened by the tears. Whenever the voluntary muscles of the eye cease to be governed by the will, as in sleep, in fainting, in coma, &c. the eye assumes this position, and on separating the lids the white only is seen. This appearance, so common in dying, Mr. Bell remarks, is not an evidence of agony, as is generally supposed, but of insensibility.

The insensible movements pointed out by Mr. Bell, certainly do prevail, but not as uniformly as he would seem to infer. The eyeball does not roll upwards when the effort is made to close the eyelids, and they are retained apart; and it is not probable that this movement takes effect in winking; neither do the eyes con-

stantly assume that position in sleeping, but are frequently directed forwards, as in waking.

The voluntary movements of the eye are executed by six muscles, the four recti, and two obliqui. The first come from the bottom of the orbit, and are inserted into the sclerotic coat of the eye at four cardinal points; the last have a direction backwards and outwards.

The recti are muscles of voluntary movements, by whose separate and conjoined action the eye may be directed to every point in the sphere of vision. When acting at the same time, they are supposed to retract the eye within the socket.

The office has generally been assigned to the obliqui of antagonizing the recti in retracting the eyeball, and also of assisting them as coadjutors in the downward and outward, and upward and inner motions of the eye.

Mr. Bell contests this opinion, and attempts to prove that these muscles do not assist the recti or voluntary muscles in the movements they impress on the eye, but are solely destined to cause the insensible movements precedingly noticed.

The eye, in addition to being influenced by the will, is under the dominion of the passions, and is an organ of expression. It may truly be styled the mirror of the soul, in which is reflected the feelings and sentiments by which it is agitated; "*even in the glasses of thine eyes I see thy grieved heart.*" The character is often delineated in their expression; "*which is the villain? let me see his eyes, that when I note another man like him, I may avoid him.*"

For the performance of these various functions, the apparatus of the eye receives a liberal distribution of nerves; of the ten cerebral nerves, six are entirely or in part appropriated to this organ. They are the second, third, fourth, part of the fifth, the sixth, and part of the seventh, and it receives, in addition, some filaments from the great sympathetic or ganglionic system. This copious distribution of nervous matter, as Mr. Bell remarks, is concentrated on a space not larger than a nut-shell.

It may be adopted as a principle sustained by observation, that, wherever more than one nerve is provided for the same organ, or apparatus of organs, different functions are performed, each requiring a different nervous action. The abundant provision of

nerves to the apparatus of the eye, is then, an evidence of a complexity of function, and the especial office of each nerve is to be investigated and determined. Difficulty and obscurity necessarily attend on this inquiry, which cannot be considered as entirely free from doubt and uncertainty.

The second or optic nerve, has been immemorially invested with the attribute of the nerve of vision. Not the least curious of the results of modern investigation has been to disprove the absolute possession of this character, at least, in the exclusive and independent manner which was assigned to it. The experiments of Magendie have clearly manifested, that to this end the concurrent action of the fifth pair is required. When this nerve is divided vision is destroyed; and observation has shown that injury and disease of this nerve is a productive cause of amaurosis.

The fifth nerve is in its character a spinal nerve, having two origins, one of which, like the spinal nerves of sensation, has, situated near its commencement, a ganglion; this branch is dispensed to the face, the tongue, the nostrils, the retina, and the exterior of the eye: the other branch has no ganglion, and passes to the lower jaw, which becomes paralyzed when it is divided, which shows it to correspond to the anterior spinal nerves, in being a nerve of voluntary motion.

When the first, or the branch having on it the ganglion, is divided, the sensibility of the face is entirely lost, and no impressions made on it can be perceived; it is then a nerve of sensation. Taste, and the sense of smell, as has already been mentioned, are also destroyed or injured, and the eye becomes perfectly insensible to irritating applications, as mechanical irritants, ammonia, &c. Blindness moreover is induced, by which is demonstrated, that the retina depends on the fifth nerve for receiving its sensibility, without which colorific rays make no impression on it.

A circumstance worthy of remark in the nervous distribution to this apparatus is, that the six muscles of the eye, by which its movements are directed, have appropriated to them three separate nerves, and from the principle already laid down, this is a proof that they execute different functions.

The eyes have impressed on them voluntary motions for the purposes of vision; but they express also the feelings and passions that sway the mind, and impel man to acts of exalted virtue, and

to deeds of deepened crime. These expressions consist in certain motions of the eyes, combined with corresponding actions of the muscles of the face, which depict joy or sorrow, surprise, disappointment, terror, anger, suspicion, jealousy, pride, &c. These pathetic movements are expressed by the muscles of the eye, and must be communicated by some of the nerves they receive. These nerves are the third, the fourth, and sixth; the two last are each appropriated to a muscle; the first to the superior oblique, the last to the external rectus muscle. This last nerve, (the sixth,) has a peculiarity attached to it, which is, a connexion with the great sympathetic; this relation is regular, without exceptions, and is certainly intended for the accomplishment of some especial design, but which it is not easy to determine.

The eyeball itself, or its muscles, have no direct connexion with the seventh nerve, but a small branch, as it issues from the cranium before the ear, is sent off to the forehead and eyelids, whose movements it governs. The destruction of this nerve entails the loss of these movements; the eyelids cannot contract and close the eye, and they remain permanently open. The consequence of this defect is the loss of vision, from the development of inflammation and opacity of the cornea, brought on by the evaporation of the tears and moisture of the eye, and the incapacity of the eye to free itself from dust and other irritating matters that may lodge on it. This fact should be a caution to operators, to be careful in meddling with this nerve in operations on the face, and in tumours near the ear.

A complex apparatus, like the organ of vision, is necessarily liable to frequent disorder and numerous imperfections. These may exist in its accessory portions; in the dioptrical apparatus adapted to the physical properties of light; and in the organic structure for the performance of the vital phenomena of this function.

The most common of these affections belong to the two first of these divisions, and are mostly inflammations, induced by the usual causes of inflammation, and often by the exercise of this sense. When this organ is exposed to strong light, and especially if it be actively employed, the continuance and force of the stimulation of the retina, is experienced by the whole eye, and its different portions become irritated and inflamed. It also suffers

sympathetically from diseases in other organs, particularly the digestive organs. This probably arises from the nervous connexion of the eye with the ganglionic system of nerves. Many of the defects of these portions of the apparatus, which have followed on irritations and inflammations of the eye, are to be remedied by surgical proceedings.

Aberrations in the exercise of this function, often depend on the nervous organs; these consist in the excess or loss, or absence of their sensibility; in the perversion, and sometimes in the exaltation of their action.

The excess of sensibility may be limited to the retina, and always accompanies its inflammation; it may also be experienced in the encephalic organs, (corpus geniculatum, and tubercula quadrigemina,) and is then a consequence of the irritation of that structure. This state is common in fevers, when light and the active exercise of vision is painful and injurious to the patient.

The loss of sensibility, which constitutes the disease known as amaurosis, depends on very different affections. It may be seated in any of the nervous organs of vision—the retina, the optic nerve, or the encephalic organs. Most commonly in these instances, it is the consequence of alteration of structure, or complete disorganization succeeding to inflammation. Amaurosis may also proceed from injury to the fifth pair of nerves, which, it has been shown, is essential for the retina to be sensible to the impression of the rays of light. When the loss of vision originates in this defect, it is accompanied with loss of sensation in the external portion of the eye, and sometimes of the face.

Vision is sometimes perverted in its exercise: it is generally a symptom of cerebral disease, and belongs to febrile delirium, occasionally, and to some forms of maniacal delirium. The perceptions in these instances, do not correspond with the impressions excited in the retina; they are wholly different, and awaken ideas that have no relation to the objects really seen, as a tree is mistaken for a man, or a simple individual for a king, or the Saviour, &c. This incongruence proceeds from the encephalic organs, which are in a state of morbid exaltation, and cannot respond in harmony to the impressions on the retina.

This condition is occasionally limited to those organs, and gives origin to phantasms. Objects are then seen with so much dis-

tinctness, they may be mistaken, and always are by the superstitious and ignorant, for realities. Most of the wonderful accounts of supernatural appearances have arisen in this manner. A gentleman with whom I am intimately acquainted in this city, and whom I often attend, of a highly nervous temperament, is exceedingly liable to be troubled in this manner. The case of Nicolai, drawn out by himself, and given by Dr. Hibbert in the Philosophy of Apparitions, is a striking instance of this affection. I have several times met with it in febrile diseases, gastro-enteritic inflammations, in which the brain was excited, but unattended with delirium.

The stimulations of this sense do not exert as extensive an influence over the organism as some of the other senses. The brain is that which chiefly is sensible of its excitements, but only when it is itself in an excited condition, as in mania a potu or delirium temulens; in fevers with cerebral excitement, &c.

The eye manifests many changes in various diseases, from its sympathetic connexion with different organs, and furnishes no mean assistance in arriving at a just diagnosis and prognosis of disease. The indications derived from this source, are to be sought for in the expression of the eye, in its movements, in the state of the conjunctiva, and the condition of the pupil, from all which the practitioner of observation and intelligence will be enabled to receive information of the highest utility.

§ 4. *Internal Sensations.*

The function of sensibility is the sentinel to which is deputed the duty of watching over the conservation of the individual: this office it performs by warning against those things that are injurious, and informing of what is useful. The external sensations are provided, that exterior matters, in which is to be sought the materials required for the reparation of the frame, should be known, and their properties inquired into and be determined.

It was not less essential that the individual should be able to acquire a knowledge of his wants, of the relations of exterior matters to those wants, and the state of his interior organs. For these purposes are established the internal or the organic sensations, which give instruction as to the condition of the organism,

and of its varied necessities, and which solicit to the performance of those acts adapted to the particular state of the different organs.

The internal or organic sensations differ in important particulars from those of the external senses; 1st, they are spontaneously developed in the organs, and do not proceed from the impression of exterior agents; 2d, their end is always to invite, and, when requisite, even to command the acts which may be required for the preservation or the exercise of functions; 3d, they are wholly uncontrolled by the will; they are independent of its action, and cannot be in any degree influenced by it: on the contrary, they have the power to subdue the will, and force it to command the actions they imperiously demand.

The internal sensations consist in organic actions, having the strongest analogy to irritations, and of which a consciousness exists; or they are perceived nearly in the manner of the external sensations, which are irritations proceeding from the direct impulsion of exterior agents transmitted to the brain. They are called the wants of the animal, from the positiveness and indispensable character of their demands.

The internal sensations are numerous, but may be arranged in three classes.

The first comprises those sensations which arise from the necessity experienced for the performance of functions, connected with the preservation and reparation of the individual, and propagation of the species. These sensations are the want of solid food, or hunger; the want of liquid aliment, or thirst; the want of atmospheric air, or of inspiration and of expiration: to this class also belong the sensations proceeding from the necessity for evacuating the excremental matters, the secretions of the nose, of the bronchiæ, &c. The sensations concerned with generation are of this order; as for the evacuation of the semen, or the connexion of the sexes; and for lying in, or the disburthening of the uterus, in females.

In a second class are to be comprised sensations, which, though analogous, yet differ from the preceding; they are, 1st, the sensations arising from the want of the action of the external senses, whence originate the arts, music, &c.; 2d, of the intellectual faculties, which introduce the cultivation of letters, the prosecution of the sciences, and the noble exertions of the intelligence; 3d, the want of the action of

the affective or moral faculties; or, as they have been appropriately named, *the wants of the heart;* it is this feeling that incites to the active exercise of benevolence, that establishes the intimacies of friendship, and weaves the strong ties of love: the inertness of the affections to many is almost a pain. An elegant authoress has said truly, *the heart must have something to love:* this want was strongly experienced by the philanthropic Howard, and is exemplified in the present day by the excellent Mrs. Fry. 4th, The want of muscular action which impels to activity of the body after repose: by this desire, sluggishness, the bane of human happiness, is felt as a burthen, from which we are glad to escape; and toil and labour, essential for the provision of our necessities, and the maintenance of health, become positive enjoyments. And lastly, the want of the expressions, or of communicating the sensations we experience, and the ideas that are framed in the mind. This want conducts to social converse, and is the origin of refined and cultivated society. In its excess it is annoying, in the production of gossips and tattlers.

This class is of a different character from the preceding. The interior feelings in which they consist, are rather sentiments than sensations. They do not partake of the nature of irritations, but arise from a local excess of the organic force, or excitability of the organs, beyond the demand then actually made on it, but which is adapted to the active exercise of the organ. It is a sentiment of force calling for action. Our organs have deputed to each a maximum of power, depending on their organic or nutritive and functional action, and which is attained by alternate activity and repose. If permitted to remain habitually unemployed, they become enfeebled in function, and degraded or atrophied in structure. Nature has kindly provided the sentiments described to urge the employment of the faculties with which we are endowed, and has not trusted them to the mere dictates of the will.

A third class of internal sensations is the reverse of the foregoing. They result from the action of our organs, and are experienced after too prolonged an exercise of the functions. They invite to a cessation of action. The exercise of our organs is an irritation, though in physiological bounds, and tends to produce an excess in their nutrition. When too long continued, like all

irritative actions, it brings on a congestive state which interferes with the functional action; this is performed with diminished energy, and a period arrives when it entirely ceases from the exhaustion of the organic force, or its production assuming a morbid direction. The immoderate employment of any organ has a termination in its hypertrophia; its function is deteriorated and prematurely exhausted. The sentiments of this class give notice when the period of healthy or physiological activity has passed, and summon us to an intermission of exertion. Of this kind is the want of repose after exercise, or the sentiments of fatigue and lassitude, and which are felt, either from corporeal or intellectual occupations; such also is the want of sleep after waking; of leisure after employment; and varied and pleasing amusements for the senses.

The internal sensations are too intimately connected with the different functions to be treated distinctly from them, without subjecting to the necessity of numerous repetitions; and a particular notice of them must be deferred to the consideration of the separate functions, to the exercise of which they are attached.

The internal sensations require the intervention of the brain for their production. In their mechanism or development they are perfectly similar to the external sensations; they necessitate an excitation in an organ, the seat of the sensation, which is either occasioned by the irritation of an exterior agent, or is spontaneously developed; this is transmitted by nerves to the cerebral centre, where perception is awakened. The three processes compose the sensation, and are essential to its formation.

The internal sensations are never indifferent; they are either pleasurable or painful. Pleasure always accompanies the satisfying a want; pain attends a resistance to its cravings; disgust, satiety and repugnance follow its abuse, or the excessive indulgence of desire, and indicate the limits we should not transcend.

The internal sensations are the expressions, the language of the organs instructing the intelligence in the acts promoting the advantage and conservation of the organism. They are hygienic mentors, whose councils should be attentively heard, and whose lessons should never be despised; they are infallible rules dictated in the interest of the economy. Every physician should lend to

them his attention, and he will find safer guides than in listening to his prejudices. Had they been consulted, never would patients, labouring under fever, have been denied cold air and cold drinks, and subjected to the horrible tortures of enduring an unappeasable thirst beneath a load of blankets; we should not now find patients, whose stomachs are too irritable to tolerate the mildest nutriment, to be dosed with active emetics, with powerful purgatives, with alcoholic compounds; we should not now have to witness the system, writhing in the agonies of gastric and cerebral inflammations, subjected to an inflammatory treatment of the most diffusible and energetic of the stimulants.

§ 5. *Morbid Sensations or Pains.*

The sensations heretofore considered, are attached to the natural or physiological exercise of the organs. When these experience a modification, however trifling, of an anormal or pathological character, new sensations are created, which are infinite in number and variety, but on which the general name of *pains* is bestowed.

These morbid sensations are in their production completely analogous to the physiological sensations. These last pushed to excess often pass into painful or morbid sensations. They consist in an irritation in a sensitive surface, its transmission by nerves, and its repetition in the cerebral organs. From the necessity of the cerebral action, or perception, to the constitution of painful sensations, we are enabled to allay the suffering they induce in suspending this faculty by the use of opium, which acts on the brain, causes its torpor, and arrests the perceptive actions.

The morbid sensations are not less useful, and are based on considerations not less wise and beneficent, than are the healthy sensations. They sound the alarm, and announce the departure of the organs from their physiological or healthy condition. They proclaim the presence of the enemy that threatens the ruin of the animal fabric, and constantly importune us to procure the means of relief.

Pain executes an office similar to, and not less authoritative than pleasure; it is a guardian watching over the conservation of

the economy. Pleasure and pain are indispensable for the preservation of individual existence; and in favour of the continuance of the species, nature has connected with it, the most voluptuous of the physical enjoyments.

Pains are more numerous than pleasures. Many portions of the structure never acquire a capacity for pleasurable sensation, but there are none that may not become painful. The most insensible parts of the animal structure, when in a state of active inflammation, are endowed with a most acute sensibility and are exquisitely painful. This state is always preceded by a change in the mode of their nutrition; they are highly vascular; their texture is softer and moister; they have assumed a more exalted degree of vitality, and have attained a higher elevation in the rank of the animal tissues. Their new capacity for sensible impressions, and sensitive actions, is a consequence of this change in their structure. In this fact we have presented the evidence, that irritation and inflammation are an exaltation of the nutritive or organic actions of the tissues.

Attempts have been repeatedly made to arrange the morbid sensations or pains. This is a difficult task; it may be said, it is an impossibility, as they assume so many and varied shades, depending on circumstances connected with the individual, and with different degrees of sensibility, of irritation, &c. Sensibility is itself modified in almost every organ, and the same exciting cause, or the same precise mode of irritation will produce sensations of different characters, as it may happen to act on, or be developed in different tissues, and even in different parts of the same tissue and organ. Four general kinds of pains were formerly designated; as gravitative, or pressing; tensive, or distention; throbbing, or lancinating; pungent, or mordicant; terebrating, or piercing. Many others are recognised, as odontalgic, neuralgic, gastralgic; contusive, rheumatic, gouty, osteocopic pains; burning, cramps, &c.

Other names may be appropriated to particular degrees of pain, or be applied to designate it when located in particular organs, or accompanying especial affections. No advantage, it is conceived, is, however, to be derived from a mere multiplication of terms, that do not convey with them some positive idea.

CHAPTER V.

The Intellectual and Moral Faculties.

The subject we have now approached in the order of our arrangement, offers considerations of the highest interest, and whose discussion is supposed to involve questions of delicate import. It is of interest as comprising the most exalted of our functions; by the possession of which man is elevated to the head of creation, that invest him with the power to subject it to his sway, and make it subserve to the interests and necessities of his existence: it possesses some delicate points in being regarded as necessarily connected, though in reality widely removed from them, with theological dogmas and venerated creeds.

In treating, however, of the intellectual and moral faculties, the question resolves itself into two distinct branches. The one is engaged in the discussion of the nature of the intellect, its modes of being, and the deep responsibilities involved in its exercise: these questions constitute metaphysical science, which we make a profession, is not embraced in our researches, or enter into the limits of our speculations. The other branch is occupied with the study of the material structure or organs, by which the acts of the intellect are performed or made palpable; by which it is associated to grosser elements, which constitute the media of its communication with the external world, and connexion with the material structure of the animal economy; by which is acquired a consciousness of the condition of the one, and the adaptation of the other, to the particular exigencies of the organism. This last department is strictly physiological, and enters into the domain of the medical sciences.

Investigations into the operations and phenomena of the intellectual faculties were supposed, for a length of time, to be foreign to medical science, and utterly incapable of investigation on the principles of physiology. This error has been successfully combated. The mind has its maladies, the most calamitous of the affections to which our nature is subject, that humanity is called

on to deplore, or our noble science to relieve; and these affections most frequently have their origin, primarily, in disorders of our material organs. But, if the mind succumb to physical causes, there must be physical organs to be affected, which are to be studied and known: and if it fall to the province of our profession "to minister to the mind diseased," it is the duty of physicians to investigate its phenomena, to analyze its operations, to locate its organs, and to become acquainted with its aberrations. Is it not absurd to invoke medical aid to remedy the alienations of the intellect, and yet deny that it is in any way connected with material organs, provided as the instruments of its actions, which alone are within range of our knowledge, and on which alone we can have the power and means to operate? Is it not a still greater absurdity to expect our science can extend its salutary aid, "to chace the ignorant fumes that mantle clearer reason," and yet refuse the intellectual phenomena to be placed within the scope of its proper researches? The right of our science to the possession of this its fairest province cannot be impeached, and it is the duty of the profession, based on conscientious and obligatory motives, to reclaim their right of propriety in this department.

Human psycology consists of two orders of faculties—the intellectual, and affective or moral; or those of the mind, and those of the heart, as they are called in common language. By the first of these, or the intellectual faculties, ideas are formed, knowledge is acquired and perfected, and man is endowed with the attribute of rationality: by the last, or the affective faculties, he is invested with his passions, the springs and impulses of his moral acts, and which, under the discipline of a well-ordered intellect, or the irregular control of the organs, elevate him to the sublimity of virtue, or degrade him to the grossness of brutal nature.

Through the senses exterior matters communicate impressions or modifications, by the process which has been investigated and described, to a central nervous mass or organ, the seat of the sensitive actions. These impressions being perceived constitute simple ideas; they are, moreover, retained, and may be recalled, in which acts consist memory; they are combined and associated together, whence proceed complex ideas—the imaginative and inventive faculties; they are compared and analyzed—the operation of reasoning—by which judgments are formed, and motives are

created, that determine the will, and give rise to our reflective actions.

This last category are the operations of faculties totally distinct from those of the sensations. They are of a more elevated order; they conduct man into a more extended and more exalted sphere of action; they bestow on him moral capabilities that are not, and cannot be derived from the mere sensations.

The external senses communicate a knowledge of all that is exterior to the intellect, but it is the intellect alone that appreciates the qualities of exterior bodies, that analyzes and compares their properties, that divines their influences, and appropriates them in diversified modes to the purposes of individual existence, to the excitation of pleasure and promotion of happiness.

The internal organic sensations, it has been demonstrated, announce to the intelligence the individual wants; they notify it of the condition of the organs; they are consequently instrumental in the physical conservation; they preside over the material organization by instructing the intellect in its interests, and directing it in the means of preservation.

But there also exist other internal sensations of a more sublimated nature, and destined to nobler purposes. These sensations are intellectual; they create our social wants; they bring man into association with his fellow being, by the necessity of this intercourse to his happiness. He is thus, by his organization, brought to constitute society, to form communities, to lay aside the proud independence and unchecked will of an isolated savage, and to submit to the obligations of self-control, and the restraints of legal authority established for the common good. From them, our existence derives its highest value, and they spread over it the most delightful of its charms; they humanize our nature; they clothe it with the most beautiful of its attributes: in them, originate the ties that bind the parent to its offspring during the helplessness of infancy, and the unprotected state of childhood: they touch the heart with the glow of love; they expand the bosom with the benevolent affections; they incite our actions by the disinterested feelings of philanthropy: from them, are derived the more dignified sentiments of love of truth, and of justice, and the moral sense of right and wrong.

The very basis of the institutions of civil society, and the ha-

bitudes and regulations of social life, are thus seen to repose on sentiments attached to the exercise of particular faculties—the moral and affective faculties—and connected with especial organs. They may be termed with propriety, the wants of the soul, and are to intellectual and moral being, what the organic sensations are to physical being; they necessitate the intellectual and moral acts by which they are to be gratified.

The Supreme Creator, by this fine mechanism, has caused human actions to be concatenated to the organization. Now, this being the same throughout the whole species, the only difference lying in the relative force of the organs, all men must possess the same faculties, the same affections, the same sentiments; they are governed by similar motives, and are influenced in a similar manner. From this provision has proceeded the uniformity, in the same general circumstances, that has characterized the thoughts, the customs, the habits of mankind in all ages, and in every portion of the globe; it is this regulation that confers the power of impelling masses of men in the same course, and directing them to the same end, by creating in them the same impressions, the same feelings, the same emotions; for all are susceptible of receiving the same impressions, and consequently their organs must, then, act simultaneously, and with similarity.

Did not this connexion exist, human actions would never be consistent; no absolute and necessary relation would hold between the impressions received, and the determinations formed from them, and it would not be possible to foresee and predict those determinations. But, by chaining down the operations of the intellect to the organization, and thus placing a limit to their activity, by compelling them to act in an exact manner, and in accordance to a certain mode, their operations are uniform, consistent, and consequent; and all who are similarly organized, when subjected to the same impressions, necessarily feel alike, think alike, and act alike. From this disposition are produced the order and harmony in the relations of society, laws obtain their power, and forms and ceremonies, which would otherwise be most absurd, their force and utility; it enables also education, taken in an enlarged acceptation, to form the character, by making permanent and lasting modifications in the organism, calling into activity and exercise certain organs and faculties, whence they receive an

energy and augmentation that secures to them a predominancy in the general system; or, by repressing and checking the action of others, to enfeeble, to degrade them, and thus diminish their influence. The energy given to the organic impressions, and the force and activity acquired by organs constantly exercised, make us slaves to habits when once established, the thraldom of which, every day's experience serves to prove, that few have the ability to escape. The importance of preventing an ascendancy of this kind in the organs, by early discontinuing injurious habits, on these views, can be comprehended; for we cannot at will change the condition of our organs, and when the sensations emanating from them have acquired a certain intensity, they overpower the will, and sweep before them the opposition of the firmest resolution. If habits be suffered, they should be only those exercising organs of the higher orders, and which do not possess a debasing and degrading tendency, like the excesses of the lower faculties, in which man assimilates to the inferior animals.

Individual differences of organization, by the greater development of certain organs and activity of faculties, occasion diversities and peculiarities of various kinds, making exceptions to the general character, and which constitute individual character. When these are in extremes, they start completely from the mass, and stand separated from it, at various distances, in bold relief. As the faculties and organs possessing this predominancy are of the superior and more intellectual grade, or of the inferior and more animal order, the actions will be virtuous, ennobling, and commendatory; or vicious, degrading, and despicable; the individual, according to the extent of his sphere and power, is the friend and benefactor of his species; or its oppressor and its scourge; for the one are destined praises, rewards, statues, and mausoleums; for the other, censures, disgrace, the prison, and the gibbet.

The ascendancy of organs and faculties pointed out, is in the natural order, and attached to the constitution, however peculiar the character of the individual may be rendered. There is an ascendancy of activity in one or more of the intellectual or moral organs and faculties that is morbid, and not in the order of nature, but an accident. The conformity which should prevail between impressions, perceptions, and ideas, is overturned, the

organs act irregularly, and the faculties are perverted. Actions cease to have a relation with the causes that produce them, and the determinations or motives cannot be predicted or ascertained. The individual ceases to be a responsible being, and his social and political existence terminates; bedlam and restraint are then his destiny.

The foregoing examination exhibits human actions to be incited in three different manners, and that they may be placed in three classes. The first, are the actions dictated by the internal organic sensations and the external sensations, which are established in the interest of the material organism, making known its wants, and the presence of injurious impressions. These actions man partakes of in common with all animals, even to the lowest. They are sometimes automatical, or performed without consciousness, as is seen in patients affected with stupor and coma, who swallow solid or liquid food when placed in the mouth, who evacuate the bladder and rectum when that office is required, and withdraw their limbs from painful applications. The same circumstances are to be observed in animals, in which consciousness has been destroyed by removing the cerebrum. This class of sensations, when not controlled, subdue the intellectual and moral faculties, and exalt above them the influences of the material organs, carrying man in his propensities to an assimilation with the lower species. The actions they provoke, when in excess, run into vices of a degrading character. They are gluttony, intemperance, sensuality, and debaucheries of every kind, and which are no more than the excesses or abuses of natural wants, conferring, by their indulgence, on the organs to which they belong, a resistless influence in the determinations of the intelligence. The offences of this class of actions are personal vices, and are directed against individual happiness, and the well-being of the economy.

The second class are those actions called forth by the exercise of the moral and affective faculties, or passions. They are of a higher order than the preceding, and have been provided for the constitution of society. Man is endowed by these faculties with the power of maintaining the varied relations that compose social life, the ends of which are best fulfilled when those faculties are equally balanced, and moderate in their activity. The actions of this class

comprise the social virtues and vices, or those actions by which society is benefited, or its interests are assailed in its separate members. The offences that attach to it are crimes against society. Some of these faculties which are more immediately connected with the individual wants, are common to the superior classes of animals as well as to man.

The third class comprises actions determined by motives created by the intellectual faculties, and which constitute actions of reflexion, of judgment, of deliberation. They are peculiar to man, they are fostered by education, they are sustained, strengthened, and purified by knowledge, and prevail in proportion to the refinement and civilization of society; which consists in the subjection of the acts of the sensations, and of the passions to the will, governed by motives of the intellect; and their repression when they would encroach on the rights, and interfere with the happiness of others. The truly great and noble-minded alone are thus happily prerogatived, and enjoy the supremacy of the intellect over the passions and the instincts, or organic sensations, on all occasions, and which they can limit within the circle they should properly be confined to. Gifted with the most exalted virtues, they betray none of the weaknesses of our nature. The actions of this class have an expansive operation; they direct society in its civil relations, they extend their sway over whole communities, they give direction to men in collective bodies, and by them, one man acquires the power to influence the destiny of his species, to change the face of science, to advance or retard the progress of knowledge, to stamp with his genius the character of his age; they form the statesman, the philosopher, the patriot.

§ 1. *The Intellectual and Moral Faculties connected with Organs.*

The examination of the two order of faculties, it is proposed to investigate, lead, in the first place, to determine positively whether they are dependent on the organization for their exercise. If no particular organs are appropriated to these faculties, of which they are functional acts, then they cannot be claimed as an appanage of physiology, or attached to the medical sciences. The following are some of the considerations that can be adduced

to demonstrate their connexion with the organization; that they depend immediately on the actions of especial organs; and, consequently, that it is the province of the physiologist and pathologist, who would form correct ideas of their maladies, to study and elucidate their history and phenomena.

1st. The sensations, which are truly a part of the intellectual phenomena, for they communicate the impressions that form ideas, are, as has been precedingly exhibited, the actions of particular organs, and have an apparatus of organs destined to their accomplishment. The intellectual and moral faculties are phenomena of the same order, and it is a fair conclusion, require a similar mode of development and exercise—that is, by particular organs.

2d. All vital actions emanate from material organs, without which they can have, for us at least, no appreciable or known mode of existence. But the intellectual and moral faculties are only forms of vital action; they are not more wonderful or recondite in their nature, than most of the other vital phenomena, and if material organs are essential for the production of the one, it is a direct inference, they are not less essential for that of the other.

3d. The causes that influence the condition of the organs, affect the exercise or condition of the intellectual and moral faculties. Thus food, drink, the weather, medicinal and morbific agents, frequently produce the most profound alterations in the state of these faculties. The mind becomes more active in its energies under some; it is cast into torpidity by others: they warm the affections and expand the heart with the most generous and benevolent feelings; they irritate the temper, and impel the passions into maddening excesses.

How great is the difference in the physical structure, in the organization of the inhabitants of the north, and the natives of the south. The impress of the climate is acknowledged in the form, the features, the temperaments, &c.; and not less characterized are its influences over the intellectual and moral qualities.

Every day is to be verified the extent to which these faculties are modified by the causes enumerated, and by the actions they establish in the organs of the economy. How completely is the whole moral of man subverted by an excessive potation of ardent

spirits; how rapidly is it subjected to the power of narcotics, and all the striking and peculiar traits that evince the possession of these faculties divine, erased and blotted out! Where is "the infinity of thought" in apoplexy, in epilepsy? How changed is the whole moral character of the individual by changes induced in the organs, even when of a light character. An attack of hemorrhoids, menstruation, pregnancy, hunger, costiveness, the act of digestion in those who have irritated stomachs, will often convert the mildest tempered and kindest individual into a passionate, morose, and almost insufferable being. As soon as these states terminate, the natural character reappears, and so different is the individual, it might almost be said, "he has two souls."

These causes are, however, material in their nature, and capable only of exerting an action on material organs. If the intellectual and moral faculties are not exercised by organs, how is it possible, then, they should be so entirely and profoundly modified by influences wholly material in their nature? Will it be said, that the immaterial principle acts independent of all organization, and yet is excited by stimuli, benumbed by narcotics, modified by climate, by aliment, by sympathetic reactions of the different organs—in fine, by whatever is capable of exerting an influence over the organic or physical structure of the economy?

4th. The psycology, or intellectual and moral endowments of an individual, are not uniform in the different periods of life, in the different states of health and disease, of sleeping and waking; and these differences are invariably concomitant with particular conditions of the organs.

Look at the new-born infant, whose brain does not receive all its development until several years after birth. It is incapable of thinking, of reasoning, of judging; it has no memory or association of ideas—of all moral qualities it is deficient. It possesses senses alone. Its actions are those of the first class, analogous to those of mere animals, and derived from external and internal sensations, or instincts. These faculties are acquired by age, are improved and perfected by education. In the ripeness and vigour of manhood, when the organism has reached the full term of its maturity, the psycological functions are enjoyed in their fullest plenitude, and man is capable of the highest intellectual

efforts, and displays the most exalted of his moral attributes. The decay to which our material organization is doomed, invades, with equal tread, the domicil of "sky aspiring and ambitious thought." In the decrepitude of age, the organs worn out and wasted, with the feebleness of infancy, comes "second childishness and mere oblivion." How melancholy an object was the intellectual and witty dean of St. Patrick's, the author of Gulliver's Travels and Tale of a Tub, sunk for years in so low a state of mental imbecility, he knew not even himself. Who has not, in his own experience, felt the fluctuations in the operations of the intellect, and the state of his moral affections? The one filled with bright conceptions, vigorous in combination, clear in deduction; the other glowing with the most generous emotions, inspired with philanthropic desires, and warmed with benevolence, or sluggish, dull, and vapid in the train of ideas; irritable and selfish in feeling. How animating is the presence of a bright sun, and the impression of a bracing air; how depressing and gloom-inspiring is a clouded sky and an easterly wind.

In disease is most strongly displayed the influence of the organs over the intellect. The febrile patient in his deliration loses the correct perception of objects, and fancies scenes and acts that have no existence. In mental alienation the faculties are irregular in their operations, the perceptions are aberrant, or the intellectual acts become a chaos of unintelligible thoughts, or are oppressed with torpid sluggishness.

Acute inflammations of the stomach are almost invariably productive of disturbance in the intellectual operations, being accompanied with delirium, or, in the more advanced stages, with stupor and coma. Now the stomach is intimately associated with the brain; and its disorders are speedily transmitted to that organ. We have here derangement in the actions of material organs, the one productive of loss of the digestive function, the other with irregularity of the intellectual faculties, or their suspension.

Mental alienation and maniacal delirium, are very frequently caused by chronic or sub-acute inflammations of the digestive, or the generative organs. A patient in the Alms-house Infirmary at this time, has just recovered from violent maniacal paroxysms attacking several times in a day, and during which it was necessary to confine her with the camisole or tight jacket. They were excited by inflam-

mation of the uterus succeeding to delivery, and have been entirely removed by directing a treatment against the uterine disease; as leeches ad-vulvam, to the hypogastric region, cups over the sacrum and loins, the warm bath, and cold emollient injections into the vagina and bowels. But how could a morbid condition of the uterus reach the soul, and disturb its functions, if it have not a dependance on material organs for the manifestation of its faculties; or in what possible manner could the means employed, and with the direction given to them, have exercised the slightest power over the actions of the soul, have restored its agitated and perturbed state to calmness, to tranquillity, and rendered it back the possession of reason, did it not exist in an absolute dependance on organs.

Chronic affections transform at times entirely the character of the individual. Napoleon was endowed with a personal and intellectual activity that fatigue could not repress, or continued labours exhaust. Always in action, sleep hardly seemed a want of his nature. On the rock of St. Helena, consumed by a chronic gastritis, half lethargic, stretched on his couch, he could not avoid remarking the change he had undergone. Where, he exclaimed, is my former energy? I, who so frequently overran Europe, can now scarce exert myself to take a turn in the garden, or keep open my heavy lids. Alas, I am no longer Napoleon.*

These faculties require, farther, an intermittence in their action, and hence the successive periods of sleeping and waking—in the first of which they are entirely suspended. They are besides exhausted by exertion, and necessitate a repose, that they may again enter into exercise with their accustomed vigour.

These facts, and numerous others might be cited in illustration, are conclusive evidences of the connexion between the intellect and moral faculties, and the action of organs. In each of the circumstances enumerated, a particular disposition of the organization, a particular condition of organs exists, and with each the psycology experiences a modification.

* Les Derniers Moments de Napoleon, par Dr. Antommarchi.

§ 2. *The Brain, the Organ of the Intellectual and Moral Faculties.*

The next point that presents itself for consideration, is to determine the organ or structure by which the psycological functions are executed.

Sensibility, it has been established already, is a function of nervous organs. Constituting an important part of the intellectual and moral phenomena, that in fact owe to sensibility their development and capacity of action, the inference from analogy is at once made, that those faculties also have nervous organs appropriated to their exercise. From numerous facts, and a great variety of considerations, we are authorized to believe, that the brain contained in the cranium is the nervous mass, by which the psycological actions are performed. Some of these it will be proper to enumerate.

1st. We have a consciousness in our intellectual operations that they are executed in the brain. The exercise of the intellectual and moral faculties is accompanied with internal sensations that we refer, the first, entirely to the seat of the brain; the second, to the brain and heart, or other organs. It is there that are felt the efforts of the understanding, and the fatigue that succeeds its prolonged exertions; and in all violent excitement of the passions, the head becomes oppressed, there is sense of fulness and tension, which often terminates in head-ache.

2d. The integrity of the brain is of absolute necessity to the production of intellectual phenomena, and the moral actions. Whenever this organ is directly implicated, as occurs in extensive injuries, or it is sympathetically affected by morbid impressions emanating from other organs, the intellectual and moral faculties suffer along with the structural derangement; they are entirely suspended, or are perverted in their mode of action. The observation of every day, and experiments without number, corroborate the accuracy of this proposition. In this purport may be adduced those instances in which portions of the cranium have been lost, leaving the brain covered only with its membranes and external skin. When pressure is made, in this spot, on the brain, consciousness is immediately suspended, and a comatose state, or

stupor, is instantly induced; the intellect and moral faculties disappear; they are held under the thumb, as it were, and are restored at pleasure to their full activity by relieving the compression. Professor Chapman, in his lectures, mentions having seen an individual with his head in this state, who was accustomed to submit himself to the experiment, and who was exhibited by the late professor Wistar to his class. In the surgical lectures of Sir Astley Cooper, by F. Tyrrel, a remarkable case is cited, in which a comatose state continued for several months with suspension of the intellectual faculties, and which were immediately restored by elevating a depressed portion of the cranium that had caused compression of the brain.

In experiments on animals, the removal of the cerebrum invariably destroys the faculties of perception, of memory, of judging, as far as they are capable of those processes, and of volition, but does not affect sensation, motion, or respiration. If disturbed, they will move and walk, and birds will fly, but, if they meet an obstacle they do not turn from, or attempt to pass round it; they continue to push against, without being able to devise the means to avoid it.

Some facts have been supposed to militate against this proposition, and have been relied on as disproving the necessity of cerebral organs for the display of the intellectual and moral faculties. These facts, which are exceptions to the general mass of observations, are some instances of wounds received in the head, and penetrating the brain; cases of hernia of the brain, in which a portion had been removed; and fungi of that organ, in which a part had been lost; and notwithstanding the structural injury thus sustained, the psycological faculties, it is asserted, suffered no detriment. It is to be remarked, however, that these observations are all deficient in accuracy; they are made in the lump, and often by those, who, believing the indivisibility of the mind, it may be fairly conjectured, inferred the integrity of all its faculties from the presence and soundness of the most prominent. Not one of these cases is reported with attention to minutiæ; the facts are not sufficiently individuated to authorize a perfect reliance on them; the patients were not put to the test, to determine whether the mind was not enfeebled in the formation of certain trains of ideas, or incapable of entertaining them; whether the character

had not undergone a change, or exhibited traits not before noticed. Inquiries directed to these, and other similar points, should have been made to give to these facts importance and validity, especially as they are opposed by positive observations entirely the reverse.

The brain, besides, is a double organ, each of its divisions being perfectly symmetrical. Now, it is a law of the symmetrical organs, that one being in a perfectly natural state, it is capable of exercising the functions, though not as perfectly, in which both are usually occupied. Sight is performed with one eye, hearing with one ear, respiration with one lung, and generation with one testicle. The same law doubtless is applicable to the brain, for nature is universal in her laws, and, consequently, the organs of one-half of the brain being unaffected, the intellectual faculties will not manifest a very striking departure from their accustomed condition, by a lesion in one or two organs, in the other half.

But we have, in addition, evidence that is conclusive, as to the duplication of the sensorial or cerebral organs, and of faculties connected with the intellect. The voluntary movements are destroyed in paralysis. This frequently affects only a portion of the body, as in hemiplegia, a vertical half of it is incapable of moving from the dictates of the will, while, in the other half, motion is perfect. In these cases, with scarce an exception, there is always found local injury, or disease located in one-half of the brain, while the opposite half is in a perfectly natural state. Thus, we have the demonstration, that each half of the brain is capable of exercising its functions independent of the other half; and exhibits its usual phenomena when sound, notwithstanding the injury which may have been inflicted on, or the disease affecting the other portion.

3d. The intellectual and moral faculties never manifest any disorder or disturbance, when the brain retains its natural condition, although other portions of the nervous structure, and other viscera, may be most seriously and deeply implicated in a morbid state or structural derangement. Fractures of the vertebræ, and diseases limited to the spinal marrow, as tetanus, &c. afford striking and conclusive instances to the illustration of the fact. All the functions depending on the integrity of this organ are disturbed, or lost, in the parts, below the seat of lesion when the af-

fection or injury is local, while the brain being in a natural state, the intellectual functions remain unaffected. The same circumstance is observed in mortal organic diseases of the stomach, lungs, heart, liver, bowels, &c.; when the brain does not sympathize in the affection, the intellect retains its force, its clearness, and activity to the last.

4th. Every individual possesses some differences in the energy and capaciousness of these faculties; and it is a general rule, with very few exceptions, that the extent of the intellect is in proportion to the size of the brain. The differences in the intellects and characters of individuals, are constituted by the more or less happy organization of the brain. The idiot and imbecile present a brain from a fourth to a half less in bulk, than the brains of those gifted with intellectual endowments of superior grade.

5th. The intellectual faculties, it was remarked, offer very striking differences in different ages, in disease and in health, in the waking and sleeping states; now, in each of these conditions the brain experiences a modification, and it is to this change in its state that alone can be ascribed the corresponding differences of the faculties. This organ does not acquire its perfect consistency until after birth, in which state the faculties cannot be said to exist; nor is its development completed until the age of puberty, before which period the faculties are yet imperfect. In those affections accompanied with disorder of the intellectual functions, it is very rare that the symptoms do not announce the brain as the seat of disordered actions, and when they are fatal, dissection seldom fails to exhibit, to instructed and experienced investigators, structural disease of the brain, or its meninges, which secondarily affect the brain itself.

6th. All animals that possess a brain exhibit evidence of psycological faculties, which correspond in number and extent to the size of the brain, and the complexity of its structure: every animal has also peculiarities in its faculties of this order, intended for the provision of its especial wants, and constructed for the state of existence it is destined to support; but the brain of every genus of animals differs from that organ in every other genus, and hence the especial psycology of each animal is owing to its especial cerebral structure. In animals for which no brain is provided, this order of faculties is never manifested.

The considerations that have been advanced, it is believed, authorized a conclusion incontrovertibly established, that the intellectual force, power, or principle, whatever may be its nature, can no more display its phenomena without organs, than can life be manifest without organs or organized structure; and that the brain is the structure composing the organs of the intellectual and moral faculties.

Bichat, while he admitted the brain to be the seat or organ of the intellect, looked on the great sympathetic, and the viscera, as the location of the moral faculties or passions. He was lead to the adoption of this opinion, by the familiar observation of the feelings experienced in the viscera, and especially in the epigastrium, from the exercise of the passions. The evidence furnished by this fact goes, however, no farther than to establish the connexion between the operations of the psycological functions, and the actions of the viscera; to set forth the influence of the mind over the body; and serves to confirm, what might have been conjectured as highly probable; that the violent emotions of the passions, the high excitement of the cerebral organs, extend a perturbing influence throughout the frame, and interrupt the healthy actions and functions of the viscera concerned in the nutritive and secretory processes of the economy; precisely the same as the disorders of the viscera, irradiated on the brain, derange the operations of the intellect. The inference would be equally logical, that the intellectual faculties were seated in the stomach, because delirium, phrenzy, and other disorders of the intellect accompany the inflammation of that organ, as that the moral faculties are located in the viscera, because their exercise is accompanied with peculiar sensations in them, or with some derangement in their actions.

In treating of the sympathetic or ganglionic division of the nervous system, its function was investigated. The inferences deduced from its anatomical distribution and connexions, from physiological and pathological phenomena, were regarded, as proving it to be the medium of nervous communication between the different viscera, and, at the same time, as establishing a connexion between them and the brain. Hence must necessarily result a community of impressions and actions between the two, not clearly perceived in the natural state and the tranquillity of

the soul, but which is openly declared in the more violent and exaggerated actions provoked by disease, or the commotions and agitations of the passions.

While it cannot be doubted, that the organs of the moral faculties and passions are situated in the brain, neither can it be denied, that the viscera are not entirely passive in their exercise. What is the exact part they perform, it is not easy to divine, but every one is conscious of sensations of a peculiar kind, having either a pleasurable or painful character, experienced in the epigastrium, in the chest, and sometimes in other parts, while under the influence of moral emotions of an agreeable, or distressing nature. The participation of different organs of the thoracic and abdominal viscera, in the actions which constitute the passions, is evidenced in the secretion of tears, or weeping in sorrow; sobbing in grief; the tremulous voice, or its total loss, with tremors of the muscular system in fear; laughter in joy; gaping in ennui; the injected eye, hurried breathing and quickened action of the heart in violent anger and rage, when uncombined with apprehensions; and in the gastric stricture experienced in the preceding painful emotions, as also in hatred, jealousy, &c. with, often, the copious secretion of bile. These effects most distinctly indicate the extension of the cerebral actions, roused by the passions or affective faculties, to the physical organs of the economy.

These organs, on the other hand, are observed to hold a decided power over the exercise of the passions, and to control their elicitation. A state of inflammatory excitement, or irritation in those organs, opposes the gentle visceral excitement of the pleasurable passions, and they can no longer be experienced. When the stomach and the thoracic organs are actively inflamed, it is not possible, even in those whose natural disposition inclines them to gaiety, to excite feelings of that character, or to provoke laughter. Joy, hope, and all the animating moral impressions are dissipated, and the mind is plunged into gloom, depression, and despair. The chronic irritation of the digestive viscera, is the most common cause of melancholy and hypochondriasis.

Irritations of the digestive apparatus are often directed on the cerebral organs, and, by exciting irritation in them, carry a positive influence into the development of the passions. Thus, irritations in the stomach metamorphose, frequently, the temper and

character; the gentle and mild become peevish and irritable, the gay morose, the fearful bold, the coward courageous, the merciful cruel. The irritations occasioned by ardent spirits in the stomach and brain, give rise to the frequent quarrels and disputes about trifles, when this pernicious habit is indulged, and the man, who, when sober, is an affectionate husband, a tender parent, a faithful friend, when under the influence of intoxication, is converted into a savage and unfeeling brute; he is borne away by the most terrible and furious emotions; he is no longer master of his actions, and is scarcely conscious of the excesses he perpetrates.

The passions, it would appear from these circumstances, are, in some measure, compound sensations and actions, resulting from the combination of the sensations and actions excited in the cerebral organs, and in the physical organs, both of which concur in, and are requisite to their production: between these two series of actions, a fixed relation is maintained.

§ 3. *Of the Cerebrum and Cerebellum, their Arrangement, and Structure.*

A general description of the encephalon was made in the commencement of the Chapter on the Functions of Relation; but it will be now requisite to present, without entering into anatomical minutiæ, the general arrangement of the cerebrum and cerebellum.

The cerebrum is composed of the two kinds of nervous matter, white medullary, and gray or cineritious substance, arranged in different manners, and divided into equal halves, called hemispheres. The exterior is disposed in a convoluted form, and is covered over by the gray or ash substance, varying in depth or thickness in different individuals. The mass of the cerebrum consists of the white or medullary substance arranged in fibres, with additions of gray substance in particular positions.

In tracing the fibres of the medullary substance of the cerebrum from the base of the brain upwards, they are seen to be continuous from the medulla oblongata, where they appear to arise, or are connected with gray substance, and form those small protuberances that are named corpora olivaria, or anterior pyramids. Here the fibres partially decussate, a portion of those on the right passing to the

left, and a portion of those on the left passing to the right. They are then to be seen engaged with the transverse fibres, connecting the lobes of the cerebellum, and forming the pons varolii, between and under which they pass without uniting with them. Emerging from the pons they enlarge, as they advance forwards and ascend, constituting the crura cerebri. Two masses of gray substance are now added, producing enlargements, which are designated thalami nervorum opticorum, and corpora striata. From these masses they receive an accession of fibrous or medullary substance, after which they spread out in the manner of a fan, or are divergent, and thus form the hemispheres of the cerebrum.

As to the ultimate disposition of these fibres two opinions have been proposed. Gall asserts that they terminate unequally, some being longer than others, by which disposition the convolutions of the surface are formed, and over which a layer of gray substance is spread.

From the gray substance thus arranged, other fibres, or new medullary substance proceed, which, passing inwards, crossing the first and returning towards the interior, constitute converging fibres, that meet in the median line, and there form the commissures, the intention of which is to unite, to combine intimately, the double and similar halves of this organ.

According to the later researches of Tiedemann and Serres, the views of Gall in this respect are not exactly correct. These accurate anatomists assert, that the medullary fibres of the peduncles or crura cerebri radiate in the hemispheres, being directed to the sides, in front, and behind, but all advancing from below upwards: they are, then, folded on themselves inwards, by which they form the superior wall or vault of the lateral ventricles, and redescending along the interior face of the hemispheres they join the pillars of the fornix. Those of the two sides approach, unite together, and produce the corpus callosum, which is, thus, a commissure of the brain, and formed of transversal fibres. Here they terminate their course, and do not continue so as to issue in a rejunction with the peduncles and corpora pyramidalia.

The hemispheres of the brain, it is very evident, from this description of their formation, and as detailed more minutely by

Tiedemann, are medullary membranes, produced by the expansion and radiation of the fibres of the cerebral peduncles, and folded up from without inwards, and from before backwards. The lateral ventricles, instead of being cavities, hollowed, as it was supposed, in the substance of the brain, are produced by the inflection of these membranes, and are, in reality, exterior to the brain. The object attained by this arrangement of the cerebral structure, appears to be the concentration of a large mass of nervous substance, and numerous organs in a small bulk, with the capability of being included in the small space of the cranial cavity, so admirably adapted to protect it from injury and violence.

This method of arranging the cerebral structure, and the order of its developments, enables us to understand the mode in which the gradual secretion of fluid, from the surface of the ventricles, in early infancy, before the hemispheres have acquired their full completion and consistency, may expand or unfold them so as to form a large sack, without affecting the faculties of the mind, or deranging in any respect the functions of the brain.

When this state occurs, there is no destruction of the structure of the brain; not even rupture of the fibres of the medullary substance has taken place; their direction alone is changed, they are more extended, so as to admit of the separation of the sides of the ventricle, and to avoid compression.

I had an opportunity of witnessing a short time past, through the kindness of Dr. J. K. Mitchell, an examination of the brain of a lad, of eight years of age, who had been the subject of chronic hydrocephalus from infancy. The head was very much enlarged, measuring twenty-nine inches in circumference. The intellectual faculties were not only unimpaired, but were considered as uncommonly acute for one of his period of life. Two days previous to his decease he met with a fall, in which he received a blow on the forehead; symptoms of inflammation of the brain succeeded, and caused his death.

The bones were firmly united; the brain presented the appearance of a sack; the convolutions were, however, perfect; they were not effaced, and the *cortical or gray substance* had not experienced the slightest derangement. The parietes were from half to three-quarters of an inch in thickness, and the cavity con-

tained five pints, by measure, of serous fluid. The only portion that was deficient was the septum lucidum; the other portions of the brain were all present, and did not appear to be affected in their structure. The internal or inflexed layer of fibres was rendered more dense than natural, and was easily separated by the fingers in a continuous sheet. In this way it was stripped from off the sides of the enlarged ventricles, was traced into the cornua, where it was found to form the pedes hippocampi, and then passed up to unite with the fornix. The dissection was made by Dr. Horner, adjunct professor of anatomy. In this case we possessed the demonstration, that no injury is sustained by the structure of the brain, in the chronic hydrocephalus, in which the intellectual faculties remain unimpaired. The only change accomplished was an elongation of the medullary fibres, by which they were adapted to the enlargement of the ventricles, or the greater separation of the inflections of the membrane than is usual.

The construction of the cerebellum is on a plan similar to that of the cerebrum. Two primitive fasciculi or bundles of fibrous medullary substance, (the corpora restiformes or posterior pyramids,) connected with gray substance in the medulla oblongata, form the crura cerebelli, meet with a mass of gray substance, the corpora denticulata, where new medullary fibres are added; they then expand or diverge, constitute the hemispheres of the cerebellum, on the periphery of which they are so arranged as to form layers, and are covered with gray substance. Converging fibres are supposed, rather than are demonstrated, to pass from this gray substance, or to proceed from the inflection of the primitive diverging fibres, and unite on the median line, where the fibres of both hemispheres meet, and constitute the pons varolii, or commissure of the cerebellum.

The brain, the local habitation of the intellectual and moral faculties, it is thus apparent, is composed of fibrous medullary substance, exactly similar to the fibrous medullary substance of which are formed the extra-cerebral nerves, the medulla spinalis, and medulla oblongata; and of gray substance, with which the white fibrous medullary substance is connected, or, as is commonly expressed, arises or proceeds from it.

The office of these different portions of the nervous structure has been already the subject of investigation, and the inference

determined from the facts in reference to them was, that the white medullary fibrous substance is a conductor of nervous oscillations, or movements, or transmitting in its functions; that it does not originate the nervous phenomena either of sensation or movements, but conveys the stimulations of exterior impressions, causing the one, to the brain; and of those producing the other, excited by the will, from the brain into the muscles. The gray substance, consequently, is that in which the nervous phenomena have their origin.

Such being the different offices of these two substances in the nervous apparatus of sensation and volition, it must be inferred, that in the cerebrum, the white fibrous substance is only transmitting or conducting, and, consequently, that the cortical or gray substance, in the convolutions of the brain, is the portion, whence is to be located the organs of psycology.

This conclusion was announced as the result of a train of reasoning and observations by Mr. Charles Bell, in an essay entitled an Idea of a New Anatomy of the Brain, published in 1810. At that time it attracted but little attention, though this opinion is now very generally entertained.

When the superior portions of the cerebrum are removed in animals, the phenomena they present appear fully to sustain the above conclusions. Sensibility to tactile impressions remains unimpaired, and the instinctive movements derived from internal sensations continue, but the animal loses the power of directing the movements to accomplish a determined purpose, or to excite movements by the mandates of volition. The intellectual faculties, as far as they are possessed, are annihilated. Pathological observations justify the same conclusion. A man was brought into the Alms-house Infirmary in a state of profound stupor, in which condition he had been found lying in a stable. He presented no vestige of intellect, and merely exhibited some signs of uneasiness when pinched with force, manifesting the existence of sensibility; the muscles were quite relaxed without subsultus, or rigidity. On examination after death, the gray substance of the anterior and superior convolutions of both hemispheres was found to be softened, and the pia mater, corresponding to that portion of the brain, was of a bright scarlet hue. This fact corresponds with numerous others to the same effect.

§ 4. *Functions of the Cerebellum.*

The functions of the cerebrum having been ascertained to be connected with the production of intellectual phenomena, an inquiry arises as to the functions of the cerebellum. These can be determined, with absolute precision, only through the medium of experiments and pathological observations.

Gall was induced from some circumstances, which are far from possessing conclusiveness, to assign to the cerebellum the instinct of propagation, and he made it the organ of amativeness. Experiments and morbid phenomena indicate, however, a very different function as attached to this structure. Flourens, in 1822, from a number of experiments on animals, was led to the conclusion, that the cerebellum possesses the power of coordinating or combining the actions of the different muscles, whose conjoined and simultaneous contraction and relaxation are requisite to perform a specific movement.

It is very obvious that few, even of our simplest motions, are performed by the contraction of a single muscle. Most of them require the concurrent aid of several; and complex movements, as those of dancing, can be executed only by the joint action of numerous muscles. It is evident, also, that in motions of this kind, many muscles must be relaxed while their antagonists are thrown into action, or they would be totally devoid of precision, regularity, and grace. The relaxation of these muscles is not a mere passive condition, but most probably is active.

In the combination of muscular contractions in complex motions, it is fairly to be presumed, that volition does not cause specifically the contraction of each separate muscle. The general movement is directed by it, and the nervous power stimulating the muscular contractions is provided, but its specific direction on the muscles to act would appear to belong to a different faculty. This conclusion appears to be authorized by the following observations; 1st, movements from sensations, and instinctive movements, when volition is paralyzed, or has no existence, as in coma, stupor, and profound sleep, are performed with regularity, and, consequently, the actions of the muscles are consentient, are coordinated, though they are neither provoked

by volition, nor regulated by it; 2d, in chorea volition is natural in its exercise; motions are willed with energy, and the muscles contract with force, but their actions are not consentaneous, the motions are irregular, and do not arrive at the end for which they are excited; each muscle contracts and relaxes without reference to the contraction and relaxation of other muscles, and the utmost dissonancy in their actions are occasioned. A person with this affection, wishes to seize on an object, he wills the motion, but the arm is tossed about in every direction, and he finds it impossible, or extremely difficult, to accomplish his intention.

Now, the organ which superintends and directs this process, is supposed by Flourens, in consequence of a series of experiments he instituted on animals, to be the cerebellum. This view of Flourens has been to a great extent confirmed by later experiments, especially by those of Bouillaud, and of Magendie. Bouillaud had adopted the doctrine of Gall, but was desirous to prove its accuracy by experiments. He wounded the cerebellum by cauterization, in order to avoid the consequences that result from hæmorrhage. This proceeding does not appear to occasion any unusual pain; the cerebellum, like the cerebrum, not being possessed of acute sensibility. The phenomenon that resulted was, uniformly, an incapacity to combine the action of the locomotive muscles. They were not affected singly in their actions; no paralysis ensued; no convulsive contractions were created; the animals continued to flex and extend their limbs with force and celerity, but they could neither stand nor give any fixed direction to their movements. The constant pathognomonic phenomena, following on the lesions of the cerebellum, in these experiments, were confined solely to disorders of the functions of locomotion and equilibration.

Bouillaud was compelled, in consequence of these observations, to abandon his first prepossessions, and he coincided with Flourens, in assigning to the cerebellum the power of coordinating the actions of the muscles, requisite to produce the movements of walking, running, flying, dancing, and to cause standing or equilibration, but he differs from Flourens in limiting its functions to the above, and some other locomotive acts: he does not extend them to all voluntary motions, as he found deglutition and some

movements of the trunk remained unaffected. It might be inferred, that there exist several centres, or organs governing the moving forces, and that the cerebellum is the one deputed for the regulation and coordination of the actions whence proceed station and locomotion.

When the cerebellum was merely irritated, in these experiments, and the injury inflicted was not so extended as to produce its destruction, anomalous or disordered contractions of the muscles, resembling exactly those that are observed in chorea, were excited, which terminated with the decline of the irritation. Profound and extensive lesion, deeply implicating the structure, had always consecutive to it, a permanent loss of equilibration, or the power of standing, and of locomotion, from the inability to direct the movements to any given purpose. No phenomena connected with the sensations, or the exercise of the intellectual faculties, were to be perceived, as produced by the destruction of the cerebellum; pain was not manifested, or the perceptive faculties and volition impaired.

This examination of the structure and offices of the cerebrum and cerebellum, presents the following summary and series of conclusions, or general facts, which are deduced from the premises, and may be regarded as established.

a. The cerebrum is the seat of the organs of the intellectual, and affective or moral faculties.

b. The cerebellum is the organ for coordinating or combining the muscular contractions, required to produce locomotive motions, and equilibration or station.

c. The ash or gray substance, the most vascular portion of the nervous structure, is that which is active in the production of nervous phenomena. It originates the power or agent, the cause of the sensations and voluntary movements; that excites the muscular contractions requisite to the performance of respiration, the expressions, &c. and which would appear to be generated by this substance in the medulla oblongata; and, finally, in the cerebrum, it constitutes the organs exercising the intellectual and moral faculties, &c.

d. That the white medullary or fibrous substance is subservient to the offices of the ash or gray substance, conveying to it im-

pressions excited on the external and internal surfaces of relation, by the nervous cords composed of this substance; and reconducting, from the ash substance, the nervous force, agency, influence, or whatever name may be given to this unknown principle or agent, into the different organs and tissues, and, probably, fluids of the organism.

e. That the white medullary or fibrous substance of the cerebrum and cerebellum is encephalic nerves, executing the same office, as the same substance has been shown to perform in nerves and the spinal marrow;* and that it transmits the actions excited in the medulla oblongata, by sensible impressions proceeding from the senses, to the gray substance composing the intellectual and affective organs in the cerebrum constituted for that purpose; and reconveys the actions of these organs into the medulla oblongata, whence they are directed into the organism, causing locomotions, the expressions, and even disturbances, when violent, of the organic and functional actions of the viscera.

To present in one summary the whole history of the encephalic structure and functions, we may here add, from the investigations entered into, and conclusions formed precedingly, when treating of the sensations:

f. That the medulla oblongata is a central point, including organs of various and important functions. Here arrive, in the first instance, the stimulations excited by external agents in the surfaces of relations or the external senses, and from the surfaces of the internal senses: when, from this point, these stimulations are transmitted to the organs of the cerebrum, they constitute perception, and create ideas in the intellectual, or awaken emotion in the affective faculties, whence result the formation of motives to determine the will: from this point, also, emanate the stimulations that excite muscular contraction, and which may be put in action; *a*, by volition moved by desire or aversion, and coordinated by the cerebellum, constituting locomotion and the expressions; *b*, by internal sensations or instincts, whence proceed respiration to supply the want of air; the muscular efforts necessary to vomiting, to defecation, to urination, &c.; and the violent muscular exertions occasioned by some morbid irritations in the stomach, attended

* Chapter IV. Sect. 1 and 2.

with severe pain; *c*, by morbid irritations transmitted from the abdominal viscera, and uterus in women, producing hysteric spasms, epilepsy, apoplexy, paralysis, &c.

g. That the encephalon, consisting of the cerebrum, cerebellum, and medulla oblongata, has, in each of its separate portions, numerous organs, (those of the cerebellum are but little known,) possessed of very dissimilar functions, yet enjoying a consentaneousness in their operations, by which is accomplished the acts of relation.

Having completed the history of the encephalon, the instrument of the intelligence, and examined the general offices assigned to its different compartments, the particular intellectual and moral faculties, with their mechanism, if the term may be admitted; the manner of their development; their natural and pathological states, become the objects of inquiry.

§ 5. *Mechanism of the Intellectual and Moral Faculties.*

The avowal has been distinctly made, that, in this investigation, there exists no intention of approaching and becoming involved in the discussion of the nature, or the essence of the intelligence or soul, or the mode of its connexion with the organism. Our researches are expressly limited, by the object in view, and the nature of the subject, to the material instruments or organs by which its operations are made manifest.

The remote causes of the movements and actions of animate and inanimate bodies; the forces that give rise to the interior organic actions; the deep and hidden source of *thought immortal;* these and other similar themes are interdicted to our inquiry. It would be entangled by them in a maze of difficulties, and obscured with abstruse and metaphysical discussions, which have exhausted the exertions of the most active and powerful minds, without a single useful purpose having been advanced, or a practical object been attained. These questions are thrown without the sphere of the certain sciences; and it is a professed intention, in this work, to restrict medicine within the limits, and to place it by the side of the certain sciences.

Dismissing all pretensions to a more lofty range of knowledge, as appertaining to our science, than that of the immediate instru-

ments or agents of the actions of animated or organized beings; of the phenomena that proceed from their actions; and the order of their occurrence under given circumstances—that is, the general laws that govern them, we advance to the examination of the intellectual and moral faculties in their manifestations, abstracted from the remote and essential causes of their existence, precisely as we examine the secretions, or any other function, abstracted from the causes of the molecular interior movements to which they are indebted for their production.

Investigated in this spirit, the intellectual and moral phenomena are placed within the range of certain science. They are rendered capable of a more positive and elaborate analysis, of being more clearly elucidated, than any other of our functional actions; for, while they are open to the same means of investigation as are the other functions; while they can be subjected, as they are, to the ordeal of observations and experiments, we possess, in addition, the consciousness, the perceptions of their operations; and, thus, their actions can be studied in ourselves, as well as in others.

The study of the intellectual and moral faculties is named metaphysics, ideology, philosophy, and is, properly, cerebral physiology. To acquire a minute acquaintance with all the details of this delightful, and most elevated department of human science, the writers, who have expressly devoted themselves to its illustration, must be consulted. Our course is confined to the mere indication of the general results of their labours, and to the settlement of principles that may serve as guides to the practitioner of medicine, amidst the difficulties that so frequently environ him, while executing the arduous and responsible task of regulating the actions of life, and in taking under his direction the physical and mental maladies of man.

At the present period, two opinions divide philosophers as respects the number of the intellectual faculties. Locke, Condillac, Destutt Tracy, and their school, admit only a single primitive faculty, from which they derive the others. They are not, however, in agreement with respect to this faculty. The sensations are elevated to this high office by Locke and Condillac, who believe, that from them may be formed the various faculties—attention, comparison, judgment, memory, reflexion, imagination, and

reasoning, all of which are supposed to be mere modifications of sensation. Rejecting this doctrine of the origin of the faculties, and the faculties also, Destutt Tracy contends that perception is the primitive and radical faculty, from which proceeds memory, judgment, and the will, which embrace all the intellectual faculties.

The Scotch philosophers, of whom Dr. Brown possesses the most brilliant reputation, have proposed different systems, but which are modifications of the preceding, and are built on the same general doctrines. It is not necessary to our purposes to designate their peculiarities.

In all of these systems, the brain, as an organ, is so little regarded, and executes so unimportant an office; is in fact so little connected with them, that it may be dispensed with entirely, without affecting in the least the reasonings on which they are sustained, the observations by which they are supported, or the conclusions to which they lead. If any notice is even taken of it, as necessarily connected with the intellect, it is considered as a simple and single organ, all of whose parts equally concur in all the acts of the mind, however varied their character.

Those who are accustomed to inspect with close and patient attention this most wonderful and complicated piece of mechanism, and who entertain a conviction, that not a fibre of our organism is created without an express and absolute use for it, are surprised, and filled with astonishment to find, that, if these prevailing and highly lauded systems are correct, this, the most elaborately perfected of our organs, more complex in its arrangement, more diversified in its component departments, than any other organ of the economy, and which might, without derogation, be looked on as a fit temple for the soul, has been framed in mere sportfulness; for so slightly is this structure regarded, so little does it enter into any connexion with the differences in the manifestation of the intellect, that a mere unformed mass, *indigesta moles*, of nervous substance, would have answered as effectually as this beautiful creation.

Opposed to the doctrine of the simplicity and unity of the intellectual faculties, presented by the preceding philosophers, Kant and Dr. Gall, have laboured to establish, that the intellect was composed of a plurality of primitive and innate faculties, to which they refer-

red the phenomena of the intellect. Of these primitive faculties, Kant designated twenty-five, but many of them are, evidently, no more than abstract and complex ideas, and cannot be looked on as primitive faculties; such are unity, negation, society, &c. Neither did Kant connect the faculties with particular organs.

Gall, in like manner, asserted the plurality of the intellectual faculties: being an excellent anatomist and physiologist, and convinced there was design in the variety of forms given to the cerebral structure, he believed the different faculties were attached each to a particular portion of this structure. Of the soundness of this doctrine, he found daily confirmative testimony, from observations presented in the practice of medicine, and to be met with chiefly in hospitals; and from observations in prisons on criminals; or on other individuals, who exhibited striking peculiarities in their mental faculties.

In these views Gall cannot be regarded as absolutely original. Many distinguished writers have very clearly announced similar opinions; but to him belongs alone the credit of having seized on them with so much force, to have arranged them with so much clearness, and to have sustained them by reasons so conclusive and forcible, by facts and observations so numerous and undeniable, that he embodied them into a beautiful and consistent system, of which he is the sole author; and became the founder of a school, supported by able and intelligent disciples.

Long before Gall, Charles Bonnet had contended in the most formal manner, not only for the plurality of the intellectual faculties, but their absolute dependence on cerebral organs. In his Palingenesia he contends, that the brain is an extremely compounded organ, or rather an assemblage of many different organs, formed by the combination and interweaving of a prodigious number of nervous fibres. He even pushed his doctrine to the extent of teaching, that the difference of sentiments was connected with the difference of the fibres; that the species of the fibre decided the species of sentiment; and the activity of its vibration caused the vivacity of thought.*

As early as the thirteenth century, Albert, bishop of Ratisbon, copying from the Arabians, gave localities, in the cavities of the

* Physiologie du Système Nerveux, par M. Georget, tome 1.

brain, to the different faculties. Bartholin, Willis, Van Swieten, and Haller, have, all of them, attached particular faculties of the intellect to especial portions of the brain; and some of them have entered into many details in support of the doctrine.

In a place, where it would little be supposed that this subject would have been discussed, and by a writer who would not have been suspected of starting an hypothesis of this kind, the works of Emmanuel Swedenborg, the plurality of the intellectual faculties, their location in different portions of the brain, and the possibility of determining the faculties by irregularities or protuberances on the cranium, are propositions as distinctly asserted, and as positively maintained, as they are by Gall.*

The relation existing between the disposition in the physical structure of the brain, and the mental faculties of animals, is remarked by Cuvier in his comparative anatomy, and he observes, "it appears, even, that certain parts have, in all classes, a development relative to certain qualities of animals."

Sœmmering possessed a full conviction of the truth of the general principle, which led him to assert, "he did not despair that the particular seats of the different orders of ideas would be discovered."

The fundamental principles of Gall, it is thus seen, are not novelties, that had never previously entered the conception of any one. Their truth might well have been suspected, had such been the case; for every general system is seen by many, who are engaged in discussions that lead to it, long previous to its establishment, but only, as it were, by imperfect glances, and in detached portions. It is reserved for some happier genius, in a more propitious age, when the universal advance of knowledge has removed the difficulties that opposed its progress, to perceive all the bearings of its facts, and the order of their arrangement; and he thus gives them the development necessary to produce conviction and obtain a general and favourable reception. Such is the history of most doctrines: they never owe their origin to a single intellect, or are settled by a single effort.

The doctrines of Gall embrace two general and distinct propo-

* Philadelphia Journal of the Medical and Physical Sciences, Vol. V. New series, p. 407.

sitions, which are not to be confounded. The first is, that the intellectual faculties and cerebral organs executing them, are multiple. The exposition of this proposition constitutes phrenology, and embraces a body of doctrines sustained by a vast number of well attested facts, and by numerous experiments and observations, daily authenticated by philosophers of every country. The testimony, as to its general truth, presented by the morbid phenomena of the nervous system, and of the intellectual and moral faculties, is so conclusive, that few well instructed and observing physicians, accustomed to analyze and reflect on what passes under their observation, have any difficulty in yielding accordance to this proposition. No problem in physiology rests on a clearer demonstration.

The second proposition, which is, probably, more curious than useful, is the possibility of recognising on the exterior of the cranium, the seats of the particular organs, or intellectual and moral faculties; of determining those possessed by individuals, and thus acquiring, from an inspection of the cranium, a knowledge of their intellectual and moral qualifications. This last proposition is far from being established, and is exposed to many, and well-founded objections; especially in the details, in the specifications, in which he and his ardent disciples have permitted themselves to indulge, and in which they have, often, wandered from the tract of severe reasoning to indulge in the fancies of speculation.

The phrenological doctrine acquires continually stability and new advocates. Its leading features are, that the intelligence or understanding consists of a plurality of primitive faculties, and that the brain contains as many different nervous systems or organs as there are faculties, each of which is appointed to the production of a special intellectual or moral operation. The psycological faculties are, consequently, attached to the exercise of organs, as functions, and, according to the number of these organs contained in the brain of an animal, and to their development, so will be the number of faculties with which the animal is gifted, and the degree of activity or energy of the faculties with which it is endowed.

The external senses have for their exercise separate external organs, and as many separate internal nervous organs. This is a matter of demonstration. We have, thus, the evidence of the ex-

istence of independent nervous organs, each having its especial function. From the uniformity observed by nature in the production of all similar phenomena, whenever a general fact is discovered, which explains any given phenomenon, we may conclude that all similar phenomena are of the same character, are caused in the same mode, and are governed under the same general laws. Hence the inference is justified, that there are as many cerebral, or nervous systems, or organs, as there are special internal senses, and particular intellectual and moral faculties. Each faculty must, then, possess in the brain a nervous organ, appropriated to its production, the same as each of the senses has its particular nervous organ. The difference between them is this: the organs of the external senses are separated from each other; they can be traced up into the brain; they are thus made tangible as it were, and brought within the scope of direct observation and positive experiment; their existence does not admit of a doubt. But it is otherwise with the organs of the intellectual and moral faculties of the brain. They are enclosed and concealed within the small cavity of the cranium, in a manner to appear, to common observation, as forming but one and the same mass, in which it is almost impossible to find a clue that will lead to the physical demonstration of their separate existence. Yet this triumph of human research is not to be despaired of. It may be yielded to laborious investigation, to minute inquiry, to accurate and multiplied observation, in the departments of comparative anatomy and physiology, of the pathology of the mental faculties, and pathological anatomy of the brain.

This doctrine, from the influence it must necessarily extend, if adopted, to the principles of self-moral government, to education, and, even, to legislation; from the new principles it will render applicable to the medical and moral treatment of nervous and mental diseases, is of sufficient importance to call for the evidence that is adducible in its support. The following are the leading arguments by which it is maintained.

1st. In all our functions, as digestion, for instance, we do not observe, that a single general power, as a *digesting faculty*, is the means by which it is accomplished, but a number of particular operations must concur for its completion, each of which is attached to, or executed by a particular organ, though they all com-

bine to the same end in a regular series. A single general faculty, for all the different intellectual and moral acts, so exceedingly diversified in nature, would be an anomaly in the functions of the economy, and not in the order of nature.

2d. Our knowledge of exterior objects is acquired through the external sensations; and they proceed from the senses appropriated to this purpose. Each sense has a special nervous organ, or apparatus, having its own specific actions, and the one can never be substituted for, or perform the actions of another; each sense can produce no other than its own peculiar sensations. Here, then, is positive evidence, that, so far as sensation is concerned, cerebral influence, or nervous power, is divisible, and that a particular nervous apparatus is consigned to each of its modifications. The same law ought to prevail in respect to the other portions of the same power, and for all the cerebral functions which are of the same order as the sensations.

3d. The cerebral structure is not homogeneous, but offers considerable diversity as to its composition, its form, and its arrangement. But what object could there be in framing so complex an organization, if there existed but a single intellectual principle or faculty, in all the actions of which the whole brain concurred. The difference of structure is a palpable argument, as to difference of function or action; and what other object can the different forms of cerebral structure possess, than for the performance of the intellectual and moral faculties, of which the cerebrum has been shown to be the seat.

4th. In the series of animal organization, from the worm to man, and in different ages of animals, a successive development of new organs is to be observed, and each new organ introduces new functions or faculties. This law prevails perfectly in the cerebral structure; every development of cerebral structure is attended with an additional faculty. Here is strongly exhibited the connexion of faculties with organs.

5th. Different individuals are endowed with intellectual faculties in every variety of force and extent. Some are poets, musicians, orators, mechanicians, arithmeticians, mimics, philosophers, formed by the hand of nature, and manifesting their peculiar talents, often, in an extraordinary manner, unaided by education, or before it had been commenced. Our faculties may be in-

vigorated and improved by cultivation and exercise, but there is a limit to the perfection they can attain, beyond which no effort can carry them, or make them rival the powers of those who are gifted with a more happy organization. In the different departments of human knowledge, of letters, science, arts, arms, &c. how few of the myriads, who have devoted to their cultivation and pursuit the full force of their talents, have acquired a distinction, that has, even, preserved their memories from oblivion; while a few, from the eminence they have reached, are the acknowledged types of excellence in their respective pursuits. They were favourities of nature, propitiously organized, and invested by her hand with their lofty capabilities: they did not make themselves.

6th. In the same individual the greatest dissimilitude is exhibited in the force and activity of the intellectual and moral faculties. Some faculties are acute, even powerful; others are feeble and defective; some persons possess a most extraordinary memory for dates, for words, &c. yet do not remember things, or comprehend complex ideas. Instances are seen in which the higher faculties and sentiments are so deficient as to approach to mental imbecility, while all the lower and inferior faculties, occupied in the common affairs of life, are astute and forcible. These dissimilitudes of the faculties, in the same individual, are not reconcileable on the scheme of a single intellectual faculty, and a single organ devoted to its exercise.

7th. The faculties do not all appear at the same time, nor do they fail at once: each age has its special psycology. No explanation of this fact can be attempted by any other principle, than the dependence of the intellectual faculties on the cerebral structure. The organization of the brain is unfolded in a slow and gradual progression, as is finely demonstrated by Tiedemann in his anatomy of the brain; and the intellectual faculties appear in succession only as the structure is perfected. All our organs, and with them the brain, deteriorate with age, and the vivacity and energy of the faculties decline, and some decay, while others are yet active, as we advance in life.

8th. It is an observation of common notoriety, that when the mind is fatigued with one kind of occupation, it can engage with vigour in one of a different kind requiring the exercise of differ-

ent faculties. It even sometimes happens, that the last, instead of adding to the fatigue, proves restorative and refreshing. On no other possible supposition can this fact be explained, than the doctrine of the plurality of faculties and organs of the intellect.

9th. Pathological observations are replete with the fullest and strongest confirmatory evidence of the correctness of the doctrine. Every case of monomania, or exclusive delirium on a small number, or a single train of ideas, furnishes proof to this point; so, also, does the extreme exaltation of a single sentiment or propensity, while all the other faculties, sentiments and propensities, unconnected with the subject of the delirium, are executed in a perfectly natural manner; all the other operations of the intellect are regular in their performance, and the judgments or opinions founded on them perspicuous and rational. The following is an instance of this kind. Dr. L., a highly respectable practitioner of medicine in an adjoining state, acquired unexpectedly a considerable property by the sudden demise of a relative. Soon after he evidenced symptoms of monomania; the subject of his mental disorder was a dread of poverty, and that he should become a common pauper. This sentiment pressed so heavily on his mind, as to lead to an attempt at suicide. He was placed in the hospital, where he remained several years, until his death. On every other subject but this one, he would reason correctly, and his ideas were in conformity with the existing order of things. A circumstance that occurred, exhibited the accuracy of his judgment on professional subjects. A patient was brought into the house, whose limb had been so much injured as to require a consultation, at which it was determined to attempt saving the limb, and not to amputate. Dr. L. entered the ward at this moment, and the late Dr. Wistar, the attending surgeon, with whom he had been intimately acquainted, invited him to view the case, and give his opinion. Dr. L. opposed the decision formed, advocated immediate amputation, and predicted that the attempt to save the limb would fail, and might involve unpleasant results. The event confirmed his judgment. The amputation became absolutely necessary in a few days, and many unfavourable occurrences ensued, attributable to the effects on the constitution from the delay.

A singular case of dementia is, at this time, in the Alms-house

Infirmary. The only aberration that is discoverable is the incapacity to associate or combine ideas. Memory on all subjects—of things, of figures, of dates, of words, of time, &c. is perfect. He has the form of ratiocination, he goes through the whole process of reasoning, and stating an argument, he lays down his premises, and forms his conclusions; but no two ideas are in connexion. He comprehends without difficulty whatever is told him, and he is capable of performing the duties assigned to him; he is able to work at his trade; and he is employed as an assistant in the department of the house for the insane.

In the number of the American Journal of the Medical Sciences, for February, 1829, I have published a case of amnesia, in which cerebral congestion suddenly induced, suspended the memory for words, without any other disorder of the intellectual faculties; all the others being in full activity.

In these instances, and similar examples sufficient to fill a volume could be cited, the whole of the intellectual faculties are not disordered, or do not depart from their natural condition: how can the intellect, then, possess unity?

10th. A wound, or physical lesion of the brain, is frequently succeeded by the loss of a single faculty, and is sometimes seen, by exciting inflammation, to bestow unwonted energy on a particular faculty. Larrey, in his surgical memoirs, mentions several cases of wounds, made by bayonets and swords, penetrating the brain, through the orbit of the eye, which entailed the loss of memory for names, but not of things, &c.

In the preceding observations are comprised some of the principal facts and arguments, advanced in support of the doctrine of a plurality of intellectual and moral faculties, and of cerebral organs, as intrusted with the performance of separate and especial faculties. They are believed to sustain the doctrine on the broadest grounds.

Spurzheim, who was associated with Gall in his anatomical investigations of the cerebral structure, and who was the ablest expositor of his system, has proposed an arrangement of the mental faculties, that has strong pretensions to be regarded as founded in nature. The mind or intellect he divides into feelings or affective faculties; and the understanding or the intellectual faculties. Each of these are again divisible into two orders or genera.

The first class, or feelings, consist of propensities and sentiments: the second class, or the understanding, of knowing faculties and reflecting faculties.

The propensities are common to man and the lower animals, and are the same as the instincts; they are productive of a propensity or internal impulse of a specific kind, and exciting special actions subservient to the advantage of the individual or the species.

The sentiments correspond to the emotions of the metaphysicians; part are common to man and the lower animals, and part are peculiar to man. They differ from the propensities in the impulse, by which they excite actions, being accompanied with moral feelings or emotions.

The knowing or perceptive faculties, the first order of the faculties of the understanding, are those by which the existence, properties, and qualities of external objects are made cognizable, and by which ideas of them are formed.

The reflective faculties, the second order of the faculties of the understanding, are of a more elevated character, and are exercised on the ideas derived from the other faculties which they act on and direct: they constitute what is called reason and reflexion.

Such is the outline of the phrenological system of Gall and Spurzheim. For the particular details of the different faculties, the facts, observations, and arguments, by which the system is sustained, and the different faculties are admitted, I must refer to their works, or to the System of Phrenology, by Mr. Combe.

Of this system it may be remarked, that so far as it assigns to the intellect a plurality of primitive faculties, and of cerebral organs devoted to their performance, it is sustained by a body of evidence, incessantly increasing, that cannot be resisted. By no other system can the phenomena of the intellect be explained on principles that are satisfactory, and that are in analogy with all the other phenomena emanating from life, especially those which are peculiar, deviating from the common order, and separating from the general mass. It is utterly impossible, on any other system, and by any other principles, to explain the pathological phenomena of the mind in its diseased condition. By adopting this doctrine the occurrence of these phenomena can be

easily comprehended, and, by attaching the faculties of the intellect to organs, a utility is perceived, and an object is determined for the complex organization of the brain and nervous system. Reject this principle, and the admirable structure of the brain is for no particular end, and its complicated arrangement exists without a special purpose. It is the only system placing the organization of the nervous system in harmony with the laws that prevail over the general structure of the animal economy.

That the phrenological system of Gall and Spurzheim, in the designation of the faculties, and their classification, is absolutely free from errors, will not be contended for, but its general truth and conformity with sound observation will not admit of refutation and denial. It may be susceptible of improvements and of additions, but its fundamental propositions are founded in nature.

From the doctrines that have been enforced, the intellectual and moral faculties can be properly regarded, in no other light, than as functions of the cerebral structure. Now, it is a law of the organism, that every function depends on two conditions—*a*, an organ primitively disposed, or adapted to the performance of the function; and, *b*, appropriate excitants exterior to the organ that call it into activity. The function is, then, a consequence of the action of the organ, and cannot necessarily be innate.

Apply this law to the intellectual and moral faculties, and it is manifest, that they are a result of innate or primitive cerebral organs, or of organic dispositions, and of exterior excitants having the power to awake impressions in the nervous tissues existing in the organs of the external and internal senses, and which are transmitted, in the manner previously discussed, to the cerebral organs, producing perceptions. Both these circumstances are of absolute indispensability for the formation of ideas, and, consequently, the hypothesis of innate ideas is devoid of foundation in nature.

This proposition may require a fuller exposition. Every being endowed with vitality, is created in the order of a fixed design, and for a certain end in this state of existence: to these it is adapted by the nature of its organization. The organization of each being is permanent; and hence it is, that classes, orders, genera, and species of animals and vegetables can be established.

These never vary; not a single being has ever been observed to deviate from its position in the animal or vegetable scale; but the same organic dispositions, and the same faculties have, universally, been preserved. In its origin or commencement, every being receives the organic dispositions, subsequently developed, which are necessary to the objects for which it was destined in its creation. Thus, vegetables are produced with roots, leaves, and flowers; fishes with gills and fins; birds with wings; insects with tentacula; man with senses, and a brain fitted for thought and the exercise of moral feelings. The organs of every being, it is obvious, are, then, constructed and arranged in such a manner, as to be found in relation with the exterior circumstances, provided in the order of nature with those qualities, or properties, by which those organs are to be excited into action. A beautiful and perfect harmony is established in this arrangement by the Creator, between the organization of beings, and the objects with which they were intended to hold relations. These objects are infinite, and hence the necessity for the immense diversity observable in the organization of beings, and which imparts utility to the endless variety that exists throughout nature.

Metaphysicians have committed a gross error in endeavouring to expound all the faculties of animals and insects, by comparing them with those that belong to man; and, where the comparison could not be traced, by attributing their actions to a divine afflatus or impulse, by which their instincts, as they have been called, are explained. Insects and animals have nervous organs, and faculties attached to them, adapted to the especial conditions of their existence. Of these faculties man can form no conception, for he has no organs that can place him in relation to the objects constituting their means of existence, and he can only divine their faculties by analogy.

Organs, from these principles it is manifest, are the fundamental element of the functions. They are primitively constituted and endowed, each with the particular faculty it is destined to exercise throughout the course of life; but they are susceptible of being modified in the mode of their action by excitants; and each organ has its peculiar susceptibility, fitting it to receive the impressions of particular excitants.

Functional actions, precisely analogous to organic actions, require, as a condition for their exercise, the influence of excitants, that are especial for each organ, and without which the functions are not called into action. For instance, without light there is no vision; without sonorous vibrations there is no hearing; without food there is no digestion; without air no respiration; without sensations there are no ideas; and without ideas no thought, or intellectual operations.

A relation must also prevail between the excitants of the functional acts and the organic faculties; when this relation ceases, the functions deviate from their natural condition; and when it passes a certain degree, the function is lost, and a pathological state of the organ ensues.

The law of the functional actions that was stated, may, then, be pronounced to be universal; no exceptions to it can be detected. It is applicable to the functional actions of all living beings. This law has, consequently, equal reference to the intellectual and moral faculties, as to the functions or faculties of the organs of organic or vegetative life; for the two orders of functions do not differ in any of their fundamental requisites.

This law, and its applicability to the intellectual functions being, thus, sustained, the formation of ideas, and the mechanism of the intellect, are cleared of the dense mystery in which they have been involved by metaphysical subtleties. They are placed on the same line with the production of the other of our organic phenomena, and are resolvable into the same general elements. From the principles comprised in this law, the following circumstances are requisites in the acquirement of ideas, and the operations of the intellect:—1st, an innate organ, the location of which has been traced to the cerebrum, appropriated to a particular intellectual or moral faculty; 2d, external agents or excitants, and internal irritations, possessing the capability of exciting particular impressions in the organs, or surfaces of the external and internal senses; 3d, sensations, or the impressions excited in the organs of the senses transmitted to the encephalon: the perception of these sensations (that is, the impressions repeated in a cerebral organ,) by the innate organ appropriated to each species of sensations, constitutes ideas; and 4th, simple ideas derived from the senses, the subjects of the purely intellectual operations, from

28

which are formed complex ideas, which are the objects of comparison, of causation, and call into exercise the reflective or reasoning faculties.

An unacquaintance with the functional law that has been illustrated, and the preceding principles consequent to it, has given vogue to two different and opposite systems in metaphysics, both of which are predicated on erroneous principles.

The first dates from Plato, who is regarded as its author, and was unquestionably its most eloquent and able expositor. In this system ideas are regarded as innate, and it is affirmed, that in the mind there exist, independent of the senses, notions, types, architypes, or eternal models of all natural objects, and which may be known from the mind itself without the aid of the senses. Modifications of the doctrine of Plato have been offered by Malebranche, who considered ideas as real beings possessed of positive properties; and by Descartes, who, changing the innate types into ideas, made them an integrant portion of the mind.

From Platonism the hypothesis of idealism, of more or less absoluteness, was derived. To such an extent was this notion carried, that the existence of a material world was denied, and the bodies and objects of nature were considered as mere illusions.

Platonism, mingled with the mysticism of the Kantean philosophy, has been revived, after a long abandonment of the field of controversy to its opposing doctrine, by Messrs. Cousin and Royer Collard, and, it is said, counts many proselytes among the fashionable world, and the literati of Paris. It can never rank amongst its advocates, those sober-minded and disciplined philosophers, who rest their belief only on demonstrable facts; and who look in the structure of our economy for the explanation of the phenomena, that are no where else to be perceived or known.

The other doctrine claims Aristotle for its founder, and is illustrated by the names, and sustained by the advocation of Locke, Condillac, Harvey, Priestly, Bonnet, Buffon, Destutt Tracy, and the Scotch metaphysicians. The intelligence or understanding, in this system, it is affirmed, is destitute of innate ideas, and at birth is, as it were, a complete tabula rasa; that the mind itself is but a single faculty, to which dispositions are imparted; that ideas are derived exclusively from sensations; and

knowledge is acquired solely from experience. *Nihil est in intellectu quin prius fuerit in sensu*, is the aphorism of the Stagirite, which is adopted and contended for by the disciples of this school.

This aphorism unquestionably is not devoid of truth, but it does not embrace the whole truth; the intellect itself is forgotten; the innate organic dispositions by which sensations awaken perceptions are overlooked, while attention is exclusively directed to the sensations, the means only of exciting or giving employment to the intellectual faculties or operations, or of calling into exertion the functions of the organs to which the intellect is attached. It might as well be asserted, that vision resides in light, or digestion in food, because vision cannot exist without light, or digestion be performed without aliment in the stomach. But, destroy the organic disposition of the eye, or the stomach, and, although light reaches the eye, there is, nevertheless, no vision; and, although there be food in the stomach, yet the process of digestion is abolished. So is it with the intellectual faculties; destroy the organic disposition of the cerebral structure, and, notwithstanding, sensitive impressions are excited in the organs of the senses, and they even reach the encephalon, yet they do not create ideas, or call into action an intellectual phenomenon.

This doctrine has been pressed by its advocates to a great extent. The differences of character, and the different degrees of knowledge, have been referred entirely to differences of education, to early impressions; or to varied power in sensorial action, but which was independent of the brain. Buffon explained the superiority possessed by man, in his intelligence, solely to the construction of his organ of touch; and Helvetius did not hesitate to assert, that, had the horse the hand of man, he would rival him in his intelligence.

The doctrine of Aristotle and Locke is, certainly, more nearly approximated to the truth, than that which adopts the dogma of the innateness of ideas; but, it is defective, in overlooking the organs of the intelligence, which are as essential to the formation of ideas, by giving the capacity to perceive the sensations, that is, to repeat the irritations in which they consist, as are the sensations themselves, or the irritations produced by exterior agents in the organs of the senses.

§ 6. *Individual Differences; Influence of Climate and Customs over the Intellect.*

The view presented of the mechanism of the intellectual faculties, and their dependence on organic structure, offers a rational and satisfactory explanation of the endless variety of individual endowments and character. The most superficial observation suffices to establish the diversity of the structure of our physical organs, and the consequent changes which are induced in the state of the functional actions. The features, and the external form of the body, it is a vulgar observation, are not similar in any two individuals; the same variety exists as to the interior organs. Examine any of the apparatus of which the organism is composed, as of respiration, of the circulation, of digestion, &c. and in every being, it will be found, that shades of difference prevail, modifying in each the functional acts.

The same general law extends to the cerebral structure, as is evidenced, in the clearest manner, by those manifesting considerable differences in the size and arrangement of the brain, where, the contrasts being striking, leave no doubt as to the reality of the differences which occur in the structure of this organ. Now, as function is held in an absolute dependence on structure, every variation of structure is attended with a difference in functional phenomena; and hence, the innate organs of the intellectual faculties being dissimilar, individuals exhibit faculties of various grades, as to force and activity, depending on this cause.

Another source of the individual differences of the intellectual faculties proceeds from the organs of the senses. The sensations, which are excitations provoked in an organ of sense, and transmitted to the brain, are the exciters of the intellectual organs, and the materials of thought. The organs of the senses differ in the same manner as the other organs, and they offer great diversities as to their acuteness; and, consequently, the vivacity of the sensations exhibits every grade of intensity, from a dullness that is scarce roused by the most energetic aggressions, to an activity which responds to the slightest impressions.

It is a law of the organism, *that functional actions correspond to their natural exciters; or a relation is established be-*

tween them. When the exciters are deficient in force and the requisite quantity, the functional actions are feeble and imperfect; when they are possessed of an inordinate activity, or are thrown with too great rapidity on the organ, the functions are deranged in their mode of action, are irregularly executed, or may even be suspended. In this manner the sensations influence the intellectual development, and form the character of the individual. Whatever tends to diminish the sensibility depreciates the activity of the mind; while its excessive liveliness, by occasioning too vivid stimulation of the cerebral organs, perverts their actions, and unhinges the regular trains of ideas, in which consist the soundness of the intellectual operations.

Through this dominant influence of the sensations in unfolding, expanding, and energizing the intellectual organs, climate and habits of living, by modifying the organs of the senses, and, thus, qualifying their susceptibilities to impressions, exert an unquestionable power over the intelligence and the moral disposition. The inhabitants of northern regions, confined for a considerable portion of the year to their huts and cabins, and occupied almost exclusively in the provision of their physical wants, have sensations limited in number, and obtuse in force. Excited solely by their wants, their intellectual acts have no higher range than to devise the means by which those wants may be supplied. *Their intellect is the intelligence for mere physical wants.* What a contrast do they present to the sensitive, voluptuous, imaginative beings, dwelling beneath tropical skies, exposed to strongly exciting and forcible impressions, quickening the sensibility, inflaming the passions, imparting power to the intellectual faculties. Here are witnessed feelings profound, deep, and enduring; passions of overwhelming intensity, of irrepressible violence, irresistible in their workings; ideas restricted in their range, but possessing extraordinary vividness and an uncontrollable energy; actions bold, daring, impetuous, without regard to consequences, yet soon relaxing into indolence. *The intellect is that of the passions*, by which it is subdued, and is directed in its exercise to their gratifications. Limited in the extent of intellectual endowments, to think is labour, and action, solely excited by the sensations and passions, is seldom awakened by reflexion. All in-

stitutions are permanent, customs unchangeable, and despotism the fixed order, and principle of society. How different from both are the residents of the temperate zones, subject to great and sudden variations, to numberless diversified impressions, but possessing little vehemence. Restless, fickle, enterprising in character; they are endowed with active intellects; their range of ideas is unlimited and never stationary; it fluctuates with unceasing agitation. The intellectual faculties, freed from the trammels of the passions and the mere physical wants, are excursive in their operations. They are not chained down to trains of ideas by which they are mastered, but every thing is brought to the test of comparison, and judged by its utility. Reflexion stimulates to action with an energy equal to moral impressions. Whatever is examined and not found in conformity to conceived ideas is assailed. Nothing is held sacred; religion, science, governments, customs, all are subjected to change, to experiment, to revolution, to improvements. In these regions alone is manifested the progress of mind, is evidenced the march of intellect; and in them is placed the moral lever, destined to elevate the intellectual and moral condition of the species.

With a less extensive influence, the habits, customs, and manners of nations, carry a modifying action into the organism, and give origin to the peculiarities constituting national character.

The same effect, on a more limited scale, may be noticed in the same community. Classes, and ranks of society, by differences in their modes of life, and the different impressions to which they are constantly subjected, from education, and a thousand other circumstances, offer constantly to observation striking peculiarities in their sensibility, and in intellectual and moral endowments.

§ 7. *Of the Affective, or Moral Faculties.*

These faculties consist in those intellectual acts which differ from the knowing and reasoning faculties. They are divided into two orders; *a*, propensities, that direct to the moral and social actions founded in the interests of the individual, and in which self is the predominant feeling; *b*, sentiments, by which

are dictated the acts that affect the interests and actions of the beings by whom we are surrounded, and with whom we are destined to hold an intimate correspondence.

In the propensities such is the faculty by which is commanded the acts approximating the sexes, for the gratification of an instinctive want; or that benign feeling attaching the parent involuntarily, with so much force, to the offspring, and without which, in its helpless condition, it would necessarily be exposed to inevitable destruction; or that feeling by which instinctively we resist aggressions on, and combat in defence of, our lives, of our property, of our personal rights, and our opinions.

In the sentiments we possess *love of approbation*, whence proceed actions, in which feelings of individual interests, or self, are sacrificed, and the interests of others, or of the community, are promoted, in order that we may attract to ourselves applause; gain the honours of society; and extort the homage of our fellow beings. The sentiments include, in like manner, *the faculty of benevolence*, which impels us, without reflexion, to exertions for the relief of those whose sufferings or dangers we happen to witness; and from the *sentiment or faculty of veneration*, age commands its reverence, authority its respect; and man delights in the adoration and worship, by which he acknowledges the existence of a Supreme Creator, and displays his gratitude for the blessings he enjoys.

The operations of the psycological faculties are attended with internal intellectual sensations, analogous to the external and internal physical sensations, or of the senses. They are more strikingly manifested, and more decidedly perceptible in the actions of the moral or affective, than of the intellectual faculties; and on this account have been named emotions, affections, desires, passions, &c. The states expressed by these terms are, either modifications in the action of a faculty or intellectual organ, or degrees of activity in its exercise, the most intense of which is designated by the word *passion*.

The study of these last faculties constitutes the science of morals: the object of which is to indicate their nature, their number, the degree and extent of their combinations; the capability of modelling them by education, repressing the development, or the too energetic action of some, favouring and exciting those of others;

by these means forming the character of the individual, and imparting to man the capability of being wise, virtuous, and happy.

Metaphysicians who have undertaken to treat of the intellectual and moral faculties, abstractedly, and as unconnected with the material organs of the economy, have attributed the moral, like the intellectual faculties, to mere modifications, or states of a single primordiate principle. This principle, La Rochefoucault, Voltaire, Volney, and others, have regarded to be self-love; and our moral acts to be resolved into a desire of those things that please, and aversion for those that are repugnant. The advocates of this doctrine have been led to an erroneous conclusion, from a mistake very natural to those who did not study in the phenomena of the organism, the explanation of their occurrence. The natural or healthy action of our organs is always accompanied with a sentiment of well-being, and, in some organs, with positive pleasure of various degrees: their unnatural action, or a resistance to their exercise, is attended with uncomfortable, and, even, painful sensations. This is true of our intellectual organs and faculties; and the pleasure experienced in our moral acts, is a result of the gratification of an internal instinctive sentiment, by the natural exercise of its organ; as the pain they inflict is derived from the opposition to its indulgence, or to the operation of its organ. This effect, or concomitant circumstance, those philosophers have mistaken for a cause: it would be as rational to conjecture, that the pleasure derived from gratifying the wants, or in the exercise of the sensations, produced the wants or the senses themselves.

Physiologists have generally looked on the moral faculties as connected with the organism, but great dissidence has prevailed amongst them as to the numbers and location of these faculties. Bordieu, Buffon, Bichat, Cabanis, and Reil, with Plato, seat them in the thoracic and abdominal viscera, or ganglionic system of nerves, under the general designation of passions. This location has been assigned to them from the marked disturbances they often occasion in the functions of those viscera, and more especially from the strong sensations experienced in them by the action of the passions.

Gall, Spurzheim, and the phrenological school, of which they laid the foundation, place the moral, as well as the intellectual faculties, in the brain; in which each faculty possesses its particular

organ. This opinion Gall has sustained by an immense mass of evidence, which may be pronounced incontrovertible.

The moral faculties are of the same order of phenomena as the intellectual; they pass into each other by almost imperceptible gradations; they are associated in their operations; they cause, like the intellectual faculties, volitions: with this identity of character, and similarity of effects, the conclusion cannot be refused, that, like the intellectual faculties, they are functions of nervous organs, and are placed with them in the brain or cerebrum.

An amalgamation of the two doctrines has been made by M. Broussais. The proposition of the phrenological physiologists, that the brain presides over, or is the seat of the moral faculties, is admitted by this eminent and acute philosopher, but he contends that the cerebral organs do not act absolutely independent of the viscera. The doctrine he advances is to this purport: the impressions received by the brain through the senses produce a movement, as it were, or vibration through the whole nervous system, in all its ramifications, and are, thus, transmitted to all the viscera. Should the specific impression have no internal surface or viscera to which it bears a relation, the operations it occasions are confined exclusively to the intellect, and no consciousness of it exists; but, if there be any of the viscera or internal surfaces to which it has a relation, the impression is recognised by it; an action is excited in the internal surface, which is returned to the cerebral centre, when an internal sensation is experienced, consciousness results, and the acts that may be required, are commanded.

The views presented by M. Broussais on the passions, or moral faculties, are the most unsatisfactory portion of his physiology. A certain degree of confusion prevails in the ideas he wishes to convey, so as to render his meaning, at times, equivocal; the principles he announces are not always consistent; and the facts on which he relies, admit of different explanations than those he proposes. He has been an eclectic in this portion of his doctrine, and attempts to reconcile different systems, conflicting in their essential characters. To this is to be attributed the discrepancies observable in the axioms he assumes, and the illogicalness of his reasoning.

M. Broussais, while he appears to admit the views of Gall in regarding the brain as embracing the organs of the intellectual

and moral faculties, adopts, notwithstanding, two doctrines of the metaphysicians. The first is the hypothesis of La Rochefoucault, Volney, &c. that the passions all emanate from self-love, of which they are modifications, and which itself is founded on, (a modification probably is meant,) the instinct of self-preservation, and on that of the propagation of the species. The last part of this proposition is difficult to be understood. The second is, that pleasure and pain, or their equivalents, love and hatred, are the sources of the affections and passions.

Either of these hypotheses is utterly inconsistent with the doctrine of distinct innate moral faculties, or, what is the same thing, organs, by which they are exercised. Yet, when speaking of benevolence, the arguments of those who would confound it, and also generosity, compassion and pity, with self-love, are refuted; and he declares, "he cannot admit, that the inclination to succour the unfortunate is not natural to man;" and further, "that it is written from all eternity in the heart of man, or rather in his intellect, that benevolence is in itself a good and laudable thing."* This is certainly in contradiction to the first proposition, and contains a clear admittance of distinct innate moral faculties for benevolence, &c.

It is a singular mistake of the metaphysicians, who have been followed, in this respect, by M. Broussais, to consider the passions as having their sources in pleasure or pain. So far are these sensations from being the causes, they are the effects of the actions of the moral faculties or passions, or cerebral organs for those functions: they proceed from their exercise. This error has been already commented on. But M. Broussais has appended to this metaphysical doctrine, that of the physiologists, as Bichat, Cabanis, &c. who seat the affections or passions in the viscera, by placing, as he does, the sensations of pain or pleasure, causing the affective or moral actions, in the viscera.

According to the doctrine under examination, no moral affection, or exercise of a passion, occurs without being preceded by visceral sensation. There can be no question, that the exercise of the moral faculties is accompanied with sensations experienced in, and referred to, the viscera; but the effects of the pas-

* Treatise on Physiology, &c. p. 123.

sions are not confined to the viscera alone, they are manifested in every part of the organism; the muscles, the organs of the senses, the skin, and even the hair, exhibit, at times, the powerfully perturbating influence of the passions over the actions of the organs, and which is extended throughout the economy. The intimate union of the abdominal and thoracic viscera with the brain, causes this phenomenon to be more decidedly, and more constantly observable in them, than in any other of the organs, but it is not special to them exclusively of the other organs: it is manifested in all. Now, this effect consecutive to, and depending on, a strong moral impression, that is, a strong excitation of an organ in the brain appropriated to a moral function, is mistaken by M. Broussais as the cause of its action, or as producing the moral impression.

Two kinds of internal or visceral sensations are connected with the exercise of the passions, which are not sufficiently discriminated by M. Broussais in his reasoning on these faculties. The one belongs exclusively to the propensities, the instinctive wants. They are, as has already been shown, states of the internal mucous tissues, analogous to irritations.* When they acquire a certain intensity, they are transmitted to the cerebral organs, where they rouse up the action of the organ appropriated to their mode of impression; they excite perception, which is no more than the activity of a cerebral organ; its function is called into exercise; the passion or affection depending on it is developed, and the actions for its gratification are commanded. The internal sensations, or instinctive wants, hold their existence on the same tenure as the external sensations; which is, cerebral organs adapted to perceive, that is, repeat, the impressions the senses transmit to the brain. Destroy the connexion between the surfaces of the internal sensations and the cerebral organs; or, let the last be placed in a condition disqualifying them to receive the impressions emanating from those surfaces, and the internal sensations or instinctive wants, are no longer experienced. This is analogous to what is observed in respect to the external sensations; and the two, belonging to the same order of phenomena, should exhibit the same general facts.

* Page 172.

The true character of the internal sensations has been entirely overlooked, or misunderstood by M. Broussais. In his mode of regarding them, they constitute the essentiality of the passions founded on them; whereas they are only one of the *conditions* by which the passions are called into action. It would be quite as apposite, reiterating nearly a similar remark, to attribute the senses to the external sensations, as to found, exclusively, the instincts or propensities on the internal sensations.

The propensities, although they are more active, and are exerted with more force when excited by the internal sensations, yet do not depend on them in an absolute manner; they are manifested even without their existence. Children, and the young of animals, before the genital organs are brought into activity, or semen is secreted, exhibit the erotic propensity or instinct. Notwithstanding M. Broussais asserts, that emasculation prevents this propensity from being experienced, the assertion cannot be admitted as uniformly correct. It is well known that the unhappy sufferers, whom a barbarous custom has subjected to mutilation, exhibit this propensity, and have not all the powers depending on it extinguished. Juvenal, describing the profligacy of the Roman matrons, mentions, expressly, that advantage was taken of this circumstance to procure a refinement in their vice, that would at this day be scarcely thought of—

> Sunt quas eunuchi imbelles ac mollia semper
> Oscula delectent, et desperatio barbæ,
> Et quod abortivo non est opus.
>
> *Sat. vi.*

Every one is well aware that those, who, by a vicious course of life have nurtured, as it were, this propensity, and given to it a strong development by habits of libertinage, continue to be tormented with impotent desires, long after all virile powers have decayed, and the internal sensations, derived from the stimulation of the spermatic fluid, have ceased to be experienced.

The second order of sensations alluded to are those that attend on, or succeed the exercise of the passions.

The affective or moral faculties, are bestowed for the purpose of commanding by impulses, often instantaneously called forth, and capable of acting with irresistible energy, the actions which

may be demanded by individual or social interests. No other source of human actions is endowed with the same degree of force and activity. It is not, therefore, surprising, that, placed in the brain, the centre of the nervous system, which is diffused throughout the organism, the organs of these faculties, when excited into action, should occasion various phenomena, and, even, disturbances of function in the abdominal and thoracic viscera, and, at times, in other organs less immediately associated with the brain. This is the true cause of the peculiar feelings experienced by the operation of the affective faculties in the thorax and the epigastrium, especially when, from their intensity, they take the name of passions. The allegation of M. Broussais is not, then, correct, that these feelings are the cause of the passions; that all impressions before they awaken the passions, or put in operation an affective faculty, must be sent into the viscera, be determined on *there* in the first instance, and then be retransmitted to the brain, before the passion or affective faculty is displayed.

The opinions of M. Broussais on these points have been examined with rather more closeness and detail, than might appear to be demanded by the subject. But, whatever is advanced by him as principles, and which possess a very extended application in physiological and in pathological discussions, from the deserved celebrity of his name, require a particular investigation; and it is seldom that his general reasoning, and the views he entertains, will not be found in conformity to sound logic, and in harmony with the phenomena of nature.

The moral or affective faculties, though exercised by cerebral organs, the same as the intellectual faculties, like them, also, cannot enter into action without excitants or impressions. These impressions are of different kinds; for the propensities or instincts, they are the internal sensations, or irritations, which, developed on the internal mucous tissues, are transmitted to the cerebral structure, and stimulate the organs provided for that specific purpose. For the sentiments, the external sensations in part, and ideas resulting from them, or the operation of intellectual faculties, are the excitants to their action; calling the sentiments into exercise, according as the sensation or the idea has relation to a particular sentiment.

The mechanism of the moral faculties is, thus, seen to bear a

perfect similitude to that of the intellectual faculties. This analogy was to be expected, since the two belong to the same order of phenomena. For the production of the passions, or the actions of the affective faculties, is required the concurrence; 1st, of special innate organs arranged in the cerebral structure; 2d, of particular impressions or irritations, on the surfaces of the internal and external senses, and sometimes the action of other intellectual or moral faculties; 3d, of the perception of these impressions by, or their repetition in, the especial cerebral organs, appropriated to a moral faculty, and to which they have a relation; or the recurrence of these impressions by memory. When these circumstances are united, the affective or moral faculties are brought into exercise, the character of which will correspond to the kind of impression made, or ideas recalled, and the particular organ or faculty to which these bear a relation, and which they uniformly excite to action.

§ 8. *Pathological States of the Intellectual and Moral Faculties, with their Mode of Production.*

The phrenological doctrine connecting the faculties of the intellect with organs, render intelligible the derangements of their operations, or their pathological condition, and the mode by which their diseases are developed. On no other ground is it possible to comprehend the various forms of mental derangement, and other affections of the intellectual and moral faculties, or the action of the causes that excite them; to institute an analysis of their phenomena, and to establish for them a natural arrangement; or to prescribe a system of treatment, that can claim to be regarded as rational.

Before advancing to the investigation of these points, it will be necessary for their clearer elucidation to premise the following axiomatical propositions, which are laws of the functions applicable to the functional operations of all the organs.

1st. The functions being the offices of the organs, can never depart from their normal or natural state, without an antecedent change in the state of the organs, or their mode of being.

2d. Functional actions are excitative of the organic or nutritive actions: that is, whenever an organ is in the exercise of a

function, it is in a state of excitement, or the first stage of irritation is developed.

As a consequence of this law, the abuses of the functional acts, their excessive excitement, or protraction in their usual degree for too long a period, terminate in the production of a pathological state, which is morbid excitement, irritation, or inflammation.

3d. Organs destined to certain functions acquire their perfect development, and an active nutrition, by the exercise of these functions. When the functions are not brought into operation, and the organ is condemned to absolute rest, its nutritive or organic actions, from the cessation of the stimulation caused by the functional actions, are enfeebled; its powers of life, its irritability, its sensibility, its nutrition, are diminished to their lowest state; asthenia exists, and the organ itself withers or decays—atony and atrophia prevail in its structure.

The muscular system strongly exemplifies this proposition: inaction of the muscles occasion them to be reduced to an extreme state of exility and feebleness; while exercise and labour swell them into their finest and largest proportions, and endow them with extraordinary force.

4th. An organ whose function is continued in action an undue length of time, by the activity of its nutrition, and from the excitement in which it is maintained, acquires its fullest development, and a species of hypertrophia is induced; the functional act is performed at first with increased vigour and activity; but the organic or nutritive actions, becoming at length over stimulated, irritation is provoked, the structure departs from its natural order; the functional actions become irregular, and finally are impaired or lost, with the progressive deterioration of the organ.

Every organ whose functional acts, though not transcending the natural or healthy standard, merely from their prolongation, passes, consequently, to a state of irritation; its susceptibility to impressions is augmented; and it is prepared to receive, or to invite to itself morbid impressions, developed in any of the organs; or to assume a highly morbid condition from accidental impressions of an unusually aggravated character to which it may be exposed.

5th. The functional actions require a period of intermittence

and repose. This proposition is immediately derived from the preceding; it is of general application, and is most strikingly manifested in the functions of relation. A forced exercise of the functions, by opposing this law of the economy, is, in itself, sufficient to provoke a pathological condition of the organs; and when to this source of disease is added an unnatural or violent exercise of the functions, this state is more certainly induced.

6th. Irritation or inflammation excited in an organ by the direct action of a morbific agent, or communicated to it by sympathy from an organ primitively diseased, causes disturbance of its functions; perverting their exercise, or totally suspending them.

7th. The physical structure of the organs is dissimilar in some respects in every individual, and a consequent difference is presented in the power or force of their organs, and the energy and activity of their functions. The functional labour, or exercise natural to one, and compatible with the healthy state, would be unnatural to another, and, if rashly attempted, would eventuate in disease.

8th. The undue or excessive exercise of the functions of an organ, or apparatus of organs, interferes with, or disturbs the functions of, some other organ or apparatus.

The application of the foregoing axioms to the diseases affecting the organs of the intellectual and affective or moral faculties, and the consequent morbid phenomena of those faculties, will explain without difficulty their mode of production and nature.

The diseases of these faculties are to be looked for, like those of all functions, in the organs by which they are performed, (Prop. 1st,) and proceed from two causes: first, their own operations being either excessive in degree, prolonged beyond their natural period of activity, or too laborious for the force of their organs: second, morbid impressions immediately affecting the organs; transmitted to them by sympathy; or translated to them by metastasis, (Prop. 4th, 5th, and 6th.)

The diseases proceeding from the preceding causes, depend upon the establishment of irritation of various intensity in the organs of these faculties; and are of sthenic character, or an exaltation of the organic actions, (Prop. 2d.) The phenomena they present are diversified, depending on the organs affected, and the extent of

disturbance invading the actions of the organs. Nearly the whole of the diseases of these faculties are embraced, in their primitive stage, in this category: it must be a most rare and extraordinary circumstance that could give origin to affections primarily of the opposite character, or of asthenia, arising from inaction of these faculties, or the deficiency of their normal or natural excitants.

The operations of the intellectual faculties are infinitely less exciting than those of the moral or affective faculties. This is more especially true in reference to the higher faculties, or those of reason or reflexion. They are not immediately called into action by the sensations or impressions on the senses, but are engaged with simple ideas derived from the first order of the intellectual faculties, the knowing or perceptive faculties; or with those derived from the sentiments. Their operations being unattended with the active stimulations of the internal and external senses, are performed in a more calm and tranquil mode, than are the actions of the organs elicited only by more energetic impressions.

The intellectual faculties are provided in the intention of making man acquainted with the qualities and properties of the material bodies exterior to himself, connected with the mundane sphere to which he belongs; and of investing him with the power of perceiving the relations of those bodies, of penetrating into their intimate natures, and unveiling their secret forces; of forming new combinations, creating new forms, and imparting new directions to physical powers. By these operations man is elevated in his moral existence, which becomes more intellectual and less animal; civilization, or the perfected state of social life is advanced; and letters, arts, the sciences owe to them their invention and cultivation. But these operations have no immediate connexion with the functions of the physical organs, and, consequently, have not received the power to influence, in a direct manner, the functional or organic actions. The exercise of the intellectual faculties alone, uncombined with the affective faculties, or the passions, for they are in numerous mental operations associated in their actions, seldom, it may not be incorrect to assert, are never the immediate cause of disease. Their excitement is not of sufficient intensity to disturb the organic actions of their own, or of other organs. They become the source of disease en-

tirely in an indirect manner, and principally by the sedentary habits they induce, preventing those physical exercises on which depend the healthy performance of the physical functions.

Those whose pursuits are chiefly intellectual, who are occupied in abstract speculations, and in whom the passions are seldom called into unusual activity, as astronomers, metaphysicians, mathematicians, &c. rarely exhibit intellectual disorders; and, as a class, are remarkably exempted from physical diseases. In mental alienation, those faculties, probably, are never in the first instance the subjects of the disease; and in most cases, amidst the violence, the irregularities, and the disturbances of the intellectual operations, it can be perceived, that these faculties are no otherwise affected, than by the false perceptions, and erroneous ideas presented to them by the moral or affective faculties, the seat of the deranged condition; and affecting them with morbid or unnatural impulses. The actions of those afflicted with mental alienation, though not in conformity to the existing order of things, is perfectly consonant to the sensations they experience, the perceptions of which they have consciousness, and the ideas that are formed. These are the sources of our knowledge, and the springs of our actions, and, if they be erroneous, the intellectual operations founded on them will of necessity be incorrect. If the madman sees, in those who approach him, a murderer, or other ill-disposed person, whom he believes designs him harm, should he possess combativeness or courage, he will attack him, and endeavour by force to prevent the mischief he apprehends; but should cautiousness or fear be the predominant sentiment, he will fly, and seek to avoid the anticipated danger. The action is rational and natural; it is the perceptive faculty that errs; or the propensity that acts with an energy too forcible to admit of reflexion.

The disorders affecting the reflective intellectual faculties originate, for the most part, from cerebral diseases, caused by immediate lesions, or by morbid irritations and inflammations, which have affected the brain, secondarily, by sympathetic communication, and which generally emanate from the abdominal viscera, or the genital organs. In some instances it occurs, however, that persons with feeble intellectual powers engage in mental labours beyond their ability, and the long-continued application of the

mind in severe study, will ultimately induce the effects of over-exercise of an organ, by the establishment of inflammation and derangement of the intellect, succeed by imbecility or other mental affections; or which will be productive of apoplexy, &c.

If the intellectual faculties are in themselves rarely the subjects, or the causes of disease, it is far different with the moral or affective faculties, and the sensations or the perceptive faculties. The actions of these faculties are highly exciting; particularly those of the propensities, which are often exceedingly perturbating by the violence of their operations; they are immediately influenced and called into activity by impressions on the surfaces of the external and internal senses, which are powerfully stimulating, and are thus exposed to be seriously disordered; they are intended to operate, in a large measure, in the interests of the organism, and are intimately associated with its organs. From these causes their organs are subject to numerous morbid impressions communicated from the physical organs, and these last are, in return, exposed to the irregular and violent excitement of the passions or affective faculties.

The affective or moral faculties from the causes enumerated, it is seen, are greatly exposed to become morbidly affected; and prove themselves also the causes of disease. These faculties, when acting with the intensity that is designated as *passion*, produce a strong excitement in the brain, with determination of blood into it, capable of terminating in the production of irritation, of inflammation, or sometimes a sudden congestion, inducing apoplexy, convulsions, epilepsy, &c. which are, often, brought on in this manner.

The diseases of the intellectual and moral faculties are not affections of the intelligence, considered as something distinct from the brain, but are, in reality, effects of irritation developed in the cerebral structure, the organs of the intelligence, by some of the modes that have been designated.

These diseases present different forms, as manifested in the perceptive organs or sensations; in the trains of ideas connected with the sentiments and intellectual faculties; and the actions to which they give rise.

In the first, irritation is the cause of erroneous perceptions, either by the impressions transmitted from the organs of sensations not producing corresponding impressions in the organs

where they are perceived; or, the mere increased excitement of the internal organs awakens sensations, forms the ideas of objects independent of external impressions. This state constantly occurs in *delirium*, and almost every febrile attack of some severity is capable of establishing it.

These organs are affected in mania temulens, the leading character of which is a delirium, consisting in false perceptions. In the lighter cases, when the attention of the patient can be fixed on any subject, the false perceptions disappear, but return immediately when the mind ceases to be engaged.

The same condition of the perceptive organs, occasionally, is manifested when no general or febrile symptoms are present, and produce hallucinations or perceptions without impressions on the senses. This circumstance has been already alluded to when treating of the sensations, and the case of Nicolai, so well described by himself, was cited, as a most remarkable illustration of this condition.

The internal sensations, that is, irritations on the internal mucous tissues, often are morbidly affected, and give rise to false instincts. Thus, malacia and pica, or depraved appetite, in which indigestible, and sometimes disgusting substances are desired with avidity, are common effects of chronic irritations of the gastric mucous surface; and bulimia, or insatiable appetite, is a consequence of the same state. The irritation of the gastric surface, the seat of the sensation of hunger, by exciting morbidly the cerebral organs, is the cause of these false perceptions. These states are usually to be observed when the irritation of the gastric mucous tissue, is accompanied with some disorder in the nervous organs. They are not unusual in epilepsy. I have, at this period, a young lad subject to this disease, in whom bulimia exists in a high degree. The approach of the paroxysms of convulsions is constantly announced by the voracity of his appetite.

It is not improbable, that, in many instances, the vice of intemperance is maintained by a similar condition. The instinct of thirst, or propensity for fluids, is, then, a morbid state like bulimia or pica, and becomes an irresistible want incontrollable by reason, or the motives offered by reflexion, by self-love, by pride, or any of the sentiments or faculties whose influence, under common circumstances, can be opposed to the indulgence of our desires, and enable us to re-

sist their gratification. It is for this reason that so few, when this morbid state of a surface of an internal sense or want has been induced, and the sensations perverted, are capable of braving their solicitations, and accomplishing a reform.

The *moral faculties* incessantly called into activity in a state of civilization, and subject, constantly, in the ramified and fluctuating interests of society to violent excitements, frequently swerve from their natural condition. They are, more than any other of the faculties of the intelligence, the causes and the seats of mental alienation. In far the larger number of the cases of this sad affliction of our nature, it will be found, that it is this class of our faculties in which the malady has its commencement, and in the disordered or perverted actions of which the disease itself consists.

The alienation of the moral faculties is very seldom general. Most frequently it is confined to a single faculty, or may embrace two or three of analogous character, and usually associated in their actions. These faculties or sentiments present constantly to the mind the same trains of ideas, and all others are excluded; for the mind can perceive but a single sensation, and be engaged with a single idea at the same instant. From the vividness and energy the ideas obtain, when the morbid excitement of the faculty is acute, they cannot be distinguished from realities, for we know exterior bodies only by the impressions on the senses, and the actions these excite in the cerebral organs; and whenever those organs have an activity equal to that which proceeds from direct impressions on the organs of the senses, sensations and ideas are formed in the intellect, which it is impossible to distinguish from those produced by realities. The ideas elicitated in this manner, are, in every respect, similar to those proceeding from the senses. They excite into activity the sentiments or faculties which would be influenced by the same sensations or ideas educed by positive impressions; the reflective faculties act on them as though caused by real objects; the actions are determined, and the expressions, the conduct, the whole bearing of the individual, are directed in conformity to the overpowering conviction with which he is possessed. This state constitutes the form of mental alienation, which is designated as *monomania;* it is the most common form of derangement of the intellect, and

takes its particular character from the sentiment, or sentiments, that may be the subject of the affection.

The moral faculties, in the states of activity, which create the affections, emotions and passions, have very diversified characters, and possess different powers over the will and the actions. The sentiments are much less exciting than the propensities, and when they are uncombined with the last, they do not lead to the commission of aggressive actions, or are attended with violence and rage. The propensities, on the contrary, when morbidly excited, generally govern volition with violent impulses, and impel to the perpetration of appalling and horrible catastrophies.

In monomania, the affection being limited to a single, or at most, to two or three agnate faculties, whose organs are always placed in conjunction, it is to bé presumed, that the morbid irritation of the cerebral structure, by which the intellectual function owes its disturbance, is also very restricted, at least in the first instance.

The causes predisposing to, and, often, exciting monomania; that is, developing irritation in a cerebral organ exercising a faculty, and increasing its susceptibility to impressions, are the strong and reiterated excitement of a particular faculty, or its prolonged exercise, by which the intellect is too deeply engaged on a single idea, or train of ideas; and, consequently, the organic structure, connected with the faculty, acquires an energy and development that is unnatural, (Prop. 2d, 4th, 5th.)

Love, religion, ambition, pride, vanity, avarice, all highly exciting, and which are the passions most frequently called into action in civilized life, are the most usual causes of monomania, and the ideas they create, are the common subjects of the delirium.

The alienation in some cases is more general; no particular train of ideas appears to fix, exclusively, the attention, but numerous transient sensations, and dissimilar, unconnected thoughts rush tumultuously upon the mind; the reflective faculties are disenthroned, or are incapable of acting on the crowd of irrelative, disassociated ideas, that start incessantly before the intellect, and vanish almost as soon as perceived. The actions are incongruous and disordered; the expressions are vague, the language incoherent, the perceptions are false, and, consequently, the ideas are in-

consistent; while, at the same time, they are wholly unconnected, and present themselves uncalled for with extreme rapidity and intensity. The rational or reflective faculties are incapable of acting on ideas crowded on them in this hurried and confused manner; they cannot command or control the disordered actions of the affective faculties and the perceptions, and have lost the power of summoning at will particular trains of ideas, or fixing the attention on them: and the most entire derangement in the intellectual operations prevails. This condition of the intellectual faculties constitutes *mania.*

But this disease assumes a variety of characters, which depend on the especial faculties that are most excited, and the ideas derived from which are the most numerous and impressive. When they belong to those that inspire anger, the violent and ireful passions, it is, then, combined with *Fury;* the bosom of the maniac appears the abode of a demon rejoicing in havoc and destruction, which he spreads around him. He vociferates, he blasphemes, he lavishes abusive epithets, and horrid imprecations, against all who approach him; and is prevented from violent aggressions only by the fetters by which he is restrained. Mania most generally partakes of this character; in some, however, the feelings are concentrated, morose, fierce, and savage; they do not express in their language and actions the same violence in their emotions, or betray the blackness of their thoughts; but, as soon as the opportunity is presented, when they can wreak their vengeance with certainty, they rush with resistless and malignant fury to the perpetration of some horrid deed. In a very few, mania is unattended with gloomy sentiments and destructive propensities, though the same irrationality, the same loss of the power of the reflective faculties over the operations of the intellect, the same hurried rapidity of thought and incoherence of ideas exist; but they lead only to incessant volubility, and corporeal restlessness.

This state of the intellectual faculties is always accompanied with great exaltation in the energy of the mental impressions and rapidity of mental operations; and is combined with augmented muscular force. In these circumstances it differs essentially from dementia, into which it generally passes, and to which

it bears some resemblance. It is seldom attended with fever; though some febrile symptoms are occasionally present.

A portion of the affective faculties possess, in some individuals, a quick susceptibility to impressions, and are excited into vigorous action, even by light causes. When these faculties are those that occasion irascible passions, fury and rage are developed; the reasoning or reflective faculties are incapable of holding them in check, and a temporary insanity exists; *ira furor brevis est*, as remarked by Horace, is literally true. This state is *Fury* regarded in a pathological light. It may exist without mental alienation, but is often united to mania, with which it has been confounded, and is, then, the *mania ferox* of Crichton, and the *manie avec délire* of Pinel; it may occur also in imbecility of the intellect, in dementia, and even idiocy. It is in these cases an accident or symptom, and is no more than ungovernable anger excited in those afflicted with these various infirmities. Several cases exhibiting this condition have come under my observation in the Alms-house Infirmary. They all existed in females; and evidently arose from neglect of moral education, and the constant indulgence of their tempers and wayward dispositions, which, from early infancy, they had been suffered to indulge, without being taught to keep them in control. In one, the paroxysm, for which she was placed in the infirmary, was brought on by jealousy, which led her to outrageous violence in a public assembly, into which she had introduced herself; such was the degree of fury excited, it was impossible to appease her rage, or to restrain the excesses of her actions, and she was carried by the police, late at night, to the Alms-house. I found her some days subsequent in the cells, subjected to the common restraints used to secure those in the violent paroxysms of mania. Believing they were instrumental in maintaining the excitement of the irascible passions, they were directed to be discontinued, and a gentler system ordered. In a short time the paroxysm subsided, and after some months she was discharged with more power to command the violence of her temper.

This unhappy state of the intellect, and which may almost generally be traced to defective education, is a common cause of crime. The following is a striking instance of the terrible ex-

cesses to which it often leads those who are unhappily subject to paroxysms of furious excitement. A girl employed on a farm in Trévoux, named Anne Lami, was sent with a fellow servant, with whom she had always lived on the best terms, to cut grass. On their return a trifling altercation ensued between them respecting the size of their bundles. Immediately Anne Lami fell on her companion, struck her in the face and neck with the knife she carried, until it broke: she then beat her on the head with a wooden shoe, (sabot,) until this also was broken to pieces. After retiring a few paces she looked back, and, seeing her victim still exhibiting signs of life, though in the struggles of death, she conceived the idea, it would be a mercy to finish her sufferings, which she accomplished with the instrument they had used in cutting the grass. After the commission of this crime, she went to her brother, related to him what had occurred, and delivered herself up to the goaler of the prison of Chatillon, to whom she recited the fatal event that had just occurred. When interrogated on the trial, as to her motives, she could assign none, except that her head had been bewildered; she knew not what she did. She was not desirous to conceal any of the circumstances, but appeared anxious to recal every particular of the occurrence. A remarkable feature in this case is, that all the witnesses testified to the general mildness of her character: she was neither mischievously inclined, nor subject to anger, and had never had a quarrel with her companion.*

In some persons these faculties are constantly in a state of so much excitement, that the slightest contrarieties, or opposition to their inclinations and will, produce violent paroxysms of fury: in this state they cannot govern their actions; and they should be accounted as insane, and treated as though labouring under mental alienation.

This unhappy disposition not unfrequently proceeds from an unrestrained indulgence of the irascible passions, by which the organs to which they are attached acquire a development and activity unnatural to them, and, consequently, are excited into ir-

* Du Degré de Compétence des Médecins dans les Questions Judiciaires. Par Elias Regnault.

regular actions by causes that would otherwise not be felt, (Prop. 4th.)

The moral precept of Horace is founded in a profound observation of nature, and contains the proper rule by which irregular propensities are to be mastered—

> Animum rege, qui nisi paret,
> Imperat; hunc frænis, hunc tu compesce catenâ.
>
> *Epis. Lib. i.* 11.

The true value of education, and well-conducted moral discipline of the propensities, of the affections and sentiments, and the deep impressions engraven on the character by those means, can only be fully appreciated in examining their influence by the lights obtained from physiology. By their aid, the organization of the intellectual and affective organs may be modified, and the character be moulded to a certain extent to the form, it is desirable, it should receive.

Sentiments the reverse of the preceding, those that are attended with pleasing emotions, are occasionally disordered by high and unusual excitement. Widely as the characters they manifest in this state, differ from those of Fury, they are of the same order, and proceed from a similar condition. The differences arise from the nature of the organs affected; the trains of ideas developed; and the feelings inspired. This affection of the sentiments connected with pleasurable emotions, is attended with mental extravagance, wild, romantic notions, great ebulliency of spirits, boisterous mirth, or exaggerated religious inspiration, according to the sentiments placed in this state of exaltation, and the preconceived ideas derived from education.

These last constantly give to all the different forms of mental alienation, and disorders of the intellect, their peculiar expression; for the ideas which are presented to the different faculties in their disordered actions, are those which had been formed by previous impressions and perceptions. In every period of society, alienation has taken its expressions from the prevailing notions, superstitions, and customs, which were exaggerated, and obtained, as it were, a positive and corporeal representation in the actions of the maniac.

The superstitions of pagan Europe, by the notions with which they filled the intellect, imposed on maniacal delirium the fancy of being a god, or demi-god, or faun, or satyr, or some divinity of its fabled Olympus. The expectation of a Messiah by the Jews, has produced a host, who have professed to be invested with that sacred character; and amongst Christians, even to the present day, numbers have proclaimed, that in them was realised the second advent.

A gross superstition, still prevalent in some provinces of Germany, produced the conceit, in disordered intellects, of being possessed by vampires; and, in the dark ages, when a belief in demons was universal, demoniacs, or the possessed, were characters very commonly assumed in mental disorders. In the New England states, during the period of enthusiastic fanaticism, which prevailed in their early settlement, and whilst directed to the persecution of witches, numbers of unfortunate women, labouring under hallucinations, accused themselves of this offence; their confessions, which clearly exhibit the aberration of their intellects, were seriously received in courts of justice, and they were condemned to suffer for this supposititious crime.

As society improves in its manners, and its customs are more refined; as knowledge progresses, and the cultivation of science uproots the ignorance and prejudices from which superstitious notions derive their origin; as religion is purified from the false systems that human vanity engraft upon it, and its doctrines are rational, in conformity with nature, and to the character of an all-wise and beneficient Creator; those sources of mental alienation are diminished; and those varieties of the disease cease to exist. Very rarely are similar cases now to be met with; and, in those which emanate from these causes, the ideas and notions are in conformity with the opinions and religious tenets that have been strongly impressed on the mind, and have excited the feelings of the sufferer.

A single idea sometimes occupies a sentiment exclusively, and is presented to the intelligence with so much force, as to debar admission to all other ideas, and to absorb the entire attention. When the sentiment or idea is of a depressing character, the affection is then termed *melancholia.* It bears an analogy to monomania, but is distinguished by the false perception being li-

mited, and exciting a single idea; in monomania, on the contrary, the delirium embraces certain trains of ideas. Of the same order of affection, but displaying a very different character, is *ecstasia*, or *ecstacy*. This morbid state consists, like melancholy, in the entire concentration of the mind on a single idea, and the exaltation of a single sentiment; but these are of an animating character; and the whole system experiences the effects of their excitement. The muscular system often presents in this affection a general spasmodic contraction.

The morbid and disordered state of the intellectual and moral faculties, throughout the preceding category of their affections, it is evident, are consequences proceeding from their own exercise. This result may be produced in two manners; *a*, from the prolonged and excessive action of a faculty; and *b*, from the intensity of its excitement, (Prop. 2d and 4th.) Either mode terminates in the development of the same state of the cerebral structure, which is irritation and inflammation, and a consequent disturbance of the functions it executes.

The brain is, however, intimately connected with the organs of the economy, especially with the digestive apparatus, more particularly the stomach and alimentary canal, and with the genital organs. Irritations developed in these, are propagated to the cerebral structure, and become fixed on some of its organs. Hence, in most cases of acute gastric irritation, delirium, hallucination, or false perception, is excited, which can be produced in no other mode, than by the transmission of the irritation awakened in the stomach to the perceptive organs of the brain.

Inflammation of the brain, which commonly attends on fevers of high grade and continued type, amongst the various affections it induces in the nervous system, frequently occasions mental alienation in some of its forms. This circumstance indicates the necessity, in the treatment of fevers, of paying the most strict attention to the local cerebral irritation, and to attack it vigorously on its first appearance.

Whatever causes induce acute inflammation in the brain, either directly, as blows, wounds, insolation, &c. or which produce it indirectly through the other organs, may provoke the excitement of mental alienation.

The most common of the causes from which it originates, are

the chronic, or sub-acute inflammations of the digestive apparatus, and the uterus, in females. These give rise with more certainty to the disease, when they concur with the functional disturbances of the brain, or the irregular and excessive excitement of the intellectual or moral faculties. The morbid irritations constantly irradiated on the brain, maintain in some of its organs an unnatural excitation, which augments their irritability, produces in them an erythism, and disposes them to a morbid condition, or may even produce that state. In numerous instances the hallucinations, or false perceptions, that prevail in mental alienation, depend on chronic inflammations of the internal mucous surfaces, the seats of the internal senses.

Mental alienation, from the view presented of the mode of its production, whether it issues from the actions of the psycological faculties inducing sur-irritation of the cerebral organs; or whether it proceeds from irritation in the organic or nutritive actions of the cerebral organs, brought on by causes influencing them directly, or indirectly by sympathy, is always a consequence of a morbid condition of the cerebral structure, and is attached to the category of diseases, whose proximate cause is sanguine irritation. It is to be treated as an affection of this nature, and as consisting in a disturbance of functions, the offices of physical organs.

§ 9. *Of the Seat of the Irritation in Mental Alienation.*

The brain is enclosed in three membranous envelopes; the dura mater, a fibrous membrane; the arachnoid, a serous membrane; and the pia mater, which is rather a reticulated tissue, or congeries of anastomosing vessels united by a transparent and loose cellular tissue, than a proper membrane. Taken together they are termed meninges.

The first of these has so very little connexion with the pathological states of the brain, it requires no particular comment. The second, or the arachnoid, is a transparent serous membrane, of extreme tenuity. Similar to the other serous membranes, it has the form of a closed sack, and exhales a fine serosity. One lamina lines the dura mater to which it adheres firmly; the other covers the encephalon in contact with the pia mater; and it pe-

netrates to the interior surfaces or ventricles, which are also lined with it. The arachnoid is thus divided into external and internal.

The external arachnoid is spread over the exterior of the encephalon, in apposition to the external surface of the pia mater, without descending into the anfractuosities formed by the convolutions, or entering the fissures separating the lobes of the brain.

The internal arachnoid is continuous with the external; and passes into the middle ventricle through an oval opening in the tela choroidea, between the corpus callosum and tubercula quadrigemina, and thence is spread over the surfaces of the other ventricles.

The serous membranes are intended to admit of movements in the organs which they surround; for this purpose they are admirably adapted, by their smooth and highly polished surfaces, lubricated with a slightly vicious serosity. The brain has certain movements, as an elevation and depression synchronous with inspiration and expiration; it has also a pulsatory motion corresponding with the pulsation of the basilar arteries; and it is liable to be affected in the movements of the body. The arachnoid is provided to facilitate those movements, which could not, in fact, occur without this arrangement, and the structure and functions of the brain would be exposed to incessant derangement. Now, inflammation of the serous membranes destroys their character by changing their smooth and slippery surfaces, which become dry and roughened, and by vitiating or altering the nature of their secreted fluid. Hence the movements of the organs they envelope, by creating intense pain and suffering, cannot be executed with freedom, or they become impossible; and the functions of those organs are consequently disordered. The inflammation of the arachnoid, it is very obvious, from regarding its uses, must be productive of disturbance in the functions and actions of the cerebral organs.

The last of the meninges is the pia mater, whose general character has been described. It is in immediate contact with the surfaces of the brain, covering them in every part, descending into its anfractuosities, and penetrating into its interior cavities: it may on this account be divided into external and internal pia mater.

The external pia mater embraces the whole exterior of the encephalon—the cerebral hemispheres, cerebellum, and the medulla oblongata. Its external surface is in contact with the arachnoid.

The internal pia mater is a continuation of the preceding, which penetrates to the internal surfaces by the fissure between the posterior extremity of the corpus callosum and the annular protuberance, and by the lateral fissures. It forms the plexus choroides and velum interpositum, or tela choroidea.

The pia mater being principally a net-work of blood-vessels spread over the brain, and sending innumerable small vessels into its substance, may be regarded as a reservoir of the vital fluid destined for the service of that organ. It holds somewhat the same relation to the brain, that the reticulated tissue does to the skin. Irritation developed in the brain, on this account, will be experienced in the pia mater, augment its circulation, cause in it congestion, and other disorders arising from its irritation; and should this condition be excited in the pia mater, it must inevitably be extended to the brain.

Between the cerebral structure and the meninges, more especially the pia mater, a most intimate connexion is maintained; so that their pathological disturbances may be regarded as common affections. In most diseases in which symptoms of disordered states of the cerebral functions are displayed, autopsy reveals meningeal derangement of structure; such as congestion, effusions of various kinds, thickening, &c. This circumstance is applicable to mental alienation. It had been observed by Morgagni, Meckel, and others, that in those who died labouring under insanity, the meninges, as well as the brain, exhibited various kinds of lesion. Greding, however, first placed the fact of meningeal lesion in a prominent view; for, according to his observations, the pia mater and arachnoid are seldom to be found in a sound state in those who have been insane. Wenzel concurs in this statement; and Haslam and Marshall, in England, record their testimony to the same purpose. M. Bayle, in the numerous dissections made at Charenton, detected, in every case of insanity, morbid changes of the structure of the meninges; and he was led, from this circumstance, to adopt the opinion, that mental alienation depends always on chronic inflammation of the meninges.

The constancy of the morbid states of the meninges in the autopsies of the insane, leaves no doubt of their participation in the pathological actions in which the disease consists; yet it may well be questioned, whether the meninges are the primary and sole seat of the disease, as M. Bayle is disposed to assert. He advances, as a proposition, that, "most of the mental alienations are the symptom of primitive chronic inflammation of the membranes of the brain."* It is to be observed, that, by chronic inflammation, M. Bayle does not mean inflammation succeeding to, or being a termination of, acute inflammation, for the designation of which, the term *chronic* is generally employed; but, that he applies it to an original inflammation. With MM. Martinet, Parent, and Montfalcon, he is inclined to deny the existence of proper chronic meningitis, as a successor to acute inflammation of the membranes. The meningeal inflammation of M. Bayle is rather sub-acute than chronic.

Notwithstanding the uniform occurrence of meningeal lesion in mental alienation, it cannot be admitted to be universally the primitive cause of the disorder. The operations of the affective faculties are frequent exciting causes of derangement; but they influence directly the cerebral organs by which they are exercised. These organs are most probably seated in the cortical or gray substance of the brain,† and which must be primarily excited in all the acts of the psycological faculties. The primitive irritation is, then, developed in the cortical or gray substance, of which the meningeal disorder is a consequence. In a practical view, it does not, however, form a point of any moment, which doctrine may be adopted; for the treatment will be directed on the same principles, whether mental alienation be regarded as a subacute inflammation affecting the meninges primitively, and inducing secondarily disorder of the psycological faculties; or, that the surface of the brain is first affected with inflammation, deranging the operations of the intellect, and which is subsequently extended to the meninges.

Mental alienation, whether monomania, mania, or melancholia, may terminate, as it frequently does, in permanent loss of the in-

* Traité des Maladies du Cerveaux et des ses Membranes.

† Page 201.

tellectual reflective, or rational faculties, or the power of combining ideas, and forming judgments. In these instances, the persistence of the inflammatory state, has produced irremediable structural derangement, either of the substance of the brain, or of its membranes. This state constitutes *dementia:* it differs from *imbecillitas*, or natural weakness of intellect, in which the faculties are not fully developed, in being always the consequence of preceding inflammation of the cerebral or meningeal structure, and in having mental alienation in some form for a precursor.

The psycological faculties are, at times, entirely suspended, so as to leave scarce a trace of their existence. This state takes place in apoplexy, coma, and stupor. A common character belongs to these affections: they consist in an irritation excited in the brain, or its membranes, which is productive of a congestion more or less rapidly superinduced. The raptus to the brain is, often, instantaneous; it is overflowed with blood, and its functions are interrupted: this forms apoplexy: in the last affections the congestion is slower, inflammation is unfolded, and the obliteration of the faculties is less complete, and is, frequently, occasioned by the effusions that have taken place—and not by sanguine congestion.

The irritation productive of these affections is seldom derived, immediately, from the operations of the intellectual and moral faculties. The first never, probably, are connected with its formation; the last, when the exciting passions are violently roused, from the stimulation they carry into the brain, and the sanguine turgescence they induce in it, are causes of its production, and immediately elicit those affections. Most commonly, however, the cerebral irritation is sympathetic, and has been transmitted to the brain from other organs, especially the stomach.

The moral faculties of an exciting nature, by their frequent exercise, prove predisposing causes of these diseases, from the excitation they determine in the cerebral structure; and its consequent increased irritability, or susceptibility to impressions. This state being induced, slight irritations reflected on the brain, produce extensive and sudden commotions. The combination of the excitement of the moral faculties, with sympathetic irritation transmitted to the brain, from the digestive, and, sometimes, genital organs, is the most common cause of apoplexy, coma, le-

thargy, and similar affections. In all individuals, whose professions give occasion to sustained excitement of the intellectual and moral faculties, and who are consequently disposed to cerebral irritation, apprehensions should be felt whenever they are attacked by gastric and enteritic irritation. The brain almost inevitably suffers in them, and, unless its irritations be early attended to, and arrested, the most serious disorders of its functions ensue. Persons of this description, particularly in the periods when their avocations call into vigorous exertion their intellectual powers, should be exceedingly cautious in producing, by a too stimulant diet, by alcoholic drinks, and erotic excitements, additional irritation proceeding from the physical organs. From these circumstances, gentlemen of the legal profession, statesmen, politicians, mercantile speculators, in whom the cerebral organs are exposed to frequent and violent excitation, in all their diseases, even of a slight character, manifest symptoms of functional disorder of the brain. They are, besides, subjected to frequent attacks of cerebral affections, vertigo, paralysis, apoplexy, inflammation of the brain, &c.

Some medicines which expend their energy on the brain, enable us to suspend, for a time, the intellectual operations; such are the narcotics. They accomplish this effect by the active stimulation they carry into the brain, which makes it a focus of fluxible movements, transporting to it the sanguine fluid, whence a congested state ensues, followed by somnolency, a lethargic condition, or an apoplectic stupor is brought on, according to the extent of the medication induced. By this means pain is alleviated from suspending perception, and deadening sensibility; and profound, radical revolutions may be accomplished in the actions going on in the economy, when it is employed with caution, with a positive knowledge of the conditions of the organs, the order of the morbid phenomena present, and a thorough acquaintance with the sympathies. Without these requisites the practice will be no more than a hazardous experiment.

§ 10. *Of the Intellectual and Moral Faculties as Causes of Diseases.*

The intellectual faculties, it has been already observed, do not possess exciting powers of great activity, or carry disturbance into the exercise of the organs. The most intense application of the reflective and reasoning faculties on abstruse questions of science, or abstract subjects, which do not involve personal interests, or are unconnected with any of the passions, have no perturbating powers, and do not disturb the functions of the organs. When they become the occasion of a pathological state, it is chiefly in an indirect manner, by the sedentary habits to which they lead, and the want of attention to a regimen, appropriate to the general habits of life.

In an early age, before the organism has acquired its proper development, the brain its perfect consolidation, or the organs are confirmed in the order of their existence, premature exercise of the intellectual faculties, are the source of many disorders. By the undue excitement of the brain, its organic actions are augmented unnaturally, the organic actions of the organs of nutrition, secretions, &c. are enfeebled; the muscular system is stunted and debilitated; the nervous system becomes morbidly irritable; and the brain subject to a variety of affections. Those highly gifted with precocious intellects possess miserable health, and are generally short-lived: they are cut off by chronic inflammations and disorganization of their viscera, or by acute inflammation of the brain.

In this period of life, the principal objects to be attempted, and which constitutes the proper education of childhood and adolescence, is, for the intellect, the regulation of the propensities and sentiments, repressing bad, and cultivating good feelings; the government of the will; the control of the desires; the formation of principles: and, for the physical organs, their development and healthy constitution, which are promoted by exercise, gymnastics, and manly sports. The acquirement of knowledge should be limited to the employment of the knowing faculties; and all subjects of an abstruse nature, that require combination, reflection, and judgment, are yet premature. The reflective faculties are the

last to be unfolded, and that reach their maturity. The studies demanding their exercise should be procrastinated to the period of youth, commencing with those that require the least efforts, and proceeding to the more difficult with the progressive force of the intellect. The ardent application of those faculties in the business, and varied occupations of life, belongs to manhood, when the organization has attained its highest perfection, and the intellectual faculties are capable of their most vigorous efforts; and which, then, may be put forth without endangering the derangement of important organs. Such is the method, as established in nature, of the cultivation and exercise of the psycological faculties, and this order cannot be inverted without the hazard of incurring the evils that arise from an improper employment of our organs, or an abuse of the faculties and functions of our economy. The neglect of adapting the employment of the mind to the force of the faculties, and the premature activity given to the operations of the brain, at the expense of the proper nutrition and development of the other organs, lay the foundation of numerous diseases. Many of the affections of the nervous system, the most difficult to control, have this origin; the derangements of the digestive apparatus; the imperfect state of the pulmonary organs; and other structural deficiences often take their rise in this circumstance. The diseases produced in this manner, are, however, less to be ascribed to the operations of the intellectual faculties, than to the vicious method pursued in their exercise and application.

The influence exerted by the moral faculties over the actions of the organs, is of an active and decisive character, when excited to the degree at which they are named *passions*. This influence should never be lost sight of by the intelligent practitioner. Numerous are the cases of disease that are to be referred to this cause; often does it modify their character, determine their event, and, when skilfully managed, frequently proves the most effective means in securing a happy issue. Every medical practitioner, of any experience, dreads, in his patient labouring under an acute affection, the influence of the depressing sentiments. Whenever they are present, the most trifling disease assumes a formidable aspect, and, however light may appear the symptoms, they are not to be too confidently trusted to; they will assume,

under the dejection of gloomy and painful sentiments, a rebellious disposition, augment in intensity, and exhibit, when least expected, an aspect truly ominous.

The truth of these observations is strongly illustrated in nostalgia: this affection of the mind, consisting of grief, melancholy, and sadness; a sense of desertion and loneliness, oppressing the feelings, and awakened by the ideas of absent home, of distant friends, kindred, and family; when it seizes on a patient affected with the slightest disease, will most generally give it a fatal termination unless its depressing influence be dispelled. Terrible was the mortality produced by this complication amongst the conscripts in the French armies. The most trifling diseases, simple catarrhs, slight gastric and enteritic inflammations, &c. became intractable, and few recovered in whom it was manifested.

This complication is always to be apprehended in those persons unaccustomed to absence from home, and who, unfortunately, are taken sick amongst strangers. It is not an uncommon occurrence in the diseases of the students, who resort to this city, in attendance on the courses of medical instruction; and to so great a degree does it aggravate their affections, that attendance on them is accompanied with extreme anxiety and constant solicitude.

While the depressing emotions produce these sinister effects, those of an animating character are most auspicious in their tendency. No cordial we can administer is gifted with half the salutary virtues, or diffuses through the system a more expansive and invigorating action, than hope and confidence infused into the sick man's breast. These, with calmness and tranquillity of soul, are always of most favourable augury, and seldom should we despair, though the conflict be violent, while they continue to buoy and sustain the patient in his extremity.

The power exercised by the moral faculties over the organism, is strikingly exhibited in scurvy. This very singular and extraordinary affection is often brought on, when causes predisposing to it have existed, by the depressing passions; and it has been observed to be suddenly dissipated by those of an animating and inspiring nature. The prospect of an engagement has been sufficient to diminish immediately the number of patients with scurvy on board of English ships of war. Captain Parry, who fully un-

derstood, and appreciated the effects of the moral faculties on the health, provided various species of amusements to divert the minds of his crew, during the long periods they were confined on board their ships, locked up in the ice, in his attempts to discover a north-west passage. To this means he very justly ascribes a considerable measure of the remarkable exemption they enjoyed from this disease.

The moral faculties in the state of activity, are productive of internal sensations that are extended into the viscera, and are of a painful or pleasurable character. The moral faculties are, however, so closely concatenated, it seldom occurs, that any one is excited alone; they most commonly act, as it were, in groups; and those sometimes of very opposite tendency are associated in the excitement; hence result mixed sensations, in which pleasurable and painful feelings both prevail.

The *emotions* and *passions*, as they are termed, are not a single moral faculty excited into activity, but a combination of faculties, which varies infinitely, although some one, more prominent than the rest, imparts the general character to the passion. On this account, it is almost an impossibility to analyse the *passions*, as they are represented in different individuals, for, in no two will precisely the same combination of faculties, the same impressions, and the same ideas exist, in circumstances apparently the same. For this reason the effects of the same passion differ materially in their influence over the viscera and the actions of the economy.

The moral faculties, it was mentioned,* are composed of two orders:—the propensities, established in the interests of the organization; and sentiments, provided for the constitution of social existence. The first, intimately associated with the viscera, are the most exciting in their action, and diffusive and energetic in their influence. The last, when they act alone, seldom produce sensations of vividness, or that state of action which is denominated passion. They are, however, frequently united with the propensities, and, then, from the intensity of their excitement, assume that character.

The modus operandi of the passions, in producing their effects

* Page 214.

on the different organs of the economy, is not known. We have no knowledge of the force or active power, generated in the nervous system, and which is its agent in accomplishing the varied phenomena to which this system gives origin. Whatever this may be, it is possessed of exceeding subtility, and either moves or vibrates with a rapidity that is inconceivable and immeasurable by the human understanding. Hence the instantaneous perception of an impression, in the point where it is made, though in reality it has traversed the nerves, been repeated in a cerebral organ, and returned back to the place where first developed; hence too the velocity of thought, and the instant transmission of moral emotions, and the excitement of the passions into the organs of the economy.

Two effects result from the operation of the passions. The first is excitement of the cerebral organs, or of the brain; and the second is a strong impression on the nutritive and secretory organs, and the tissues of the organization, often disturbing their functions, and deranging their organic actions.

The first, or the excitation of the brain, is apparent in the intestine sensation of fulness experienced in the head; the headaches that supervene on lively emotions; the flushed countenance and injected eyes of those whose passions are highly excited: how common is it for the passions to occasion hysterical paroxysms; they have been known to cause delirium and mania; and fatal apoplexies have been induced by the excessive congestions they have invited into the brain.

The second order of effects are more common, and probably more striking. No one will contest the influence of the moral emotions, and the passions over the heart. In common language they are placed in this organ, so frequently does it respond to their stimulations, and so entirely is it placed under their government. The same is true of the organs of respiration, which are simultaneously influenced with the heart: in familiar observation the feelings of the breast are synonymous with the passions.

In violent moral excitement, death has been induced by ruptures, and by spasms of the heart; and by hæmorrhages from the lungs. Morbid affections of the heart, its chronic irritation, and enlargement, are frequently to be traced to the excesses of the passions. How often, in violent grief, is heard the exclamation,

"oh, my heart will burst!" Several of the cases of enlargement of the heart, that have been under my care, were brought on by moral causes, originating in domestic afflictions. The vivacity of the moral emotions in women, will give a probable explanation of the greater frequency of the diseases of the heart in them, than in men; the proportion of which is, as four or five to one.

Next to the heart and lungs, the stomach takes rank, as to its susceptibility to moral impressions. Every one is conscious of the various sensations referred to the epigastric region under the excitement of the passions, especially those of a painful nature. Digestion is frequently interrupted, sometimes suspended, and vomiting produced, by lively moral emotions.

The secretory organs manifest this influence in a striking manner. The bile is sometimes poured out so freely, in some passions, especially anger and jealousy, as to be ejected by the stomach, to jaundice the skin, and cause diarrhœas. The urinary organs, it is well known, are likewise stimulated, and their secretion rendered profuse. The saliva, it is said, is changed in its properties, and even acquires poisonous qualities in extreme paroxyms of anger. Nothing is more familiar than the effect of moral emotions in arresting the secretion of mucus in the fauces, producing thirst, and huskiness of the voice; their influence over the lachrymal secretion is a circumstance of too common observation to be more than intimated.

The muscular system, both of voluntary and involuntary movements, displays the controlling agency of the moral faculties in an eminent degree. Those muscles, whose actions cause the expressions, picture, constantly in the face, the interior feelings; but the whole of the locomotive apparatus becomes affected in the more active operations of the passions; as in anger, which gives to them force, energy, and great mobility; or in fear, which debilitates and throws them into tremulous movements. Epileptic convulsions are, often, established in this manner, and once commenced, it becomes almost an impossibility to prevent their recurrence.

The visceral or involuntary muscles exhibit decidedly the perturbating power of the passions extended into the organism. Sudden emotions, as of fear, terror, &c. often effect an immediate evacuation of the bowels, and a discharge of urine from the bladder. Feelings of a lighter character will cause this last operation:

diffident individuals when they appear in public experience contractions in the bladder, and are forced to empty its contents, which they find it difficult to retain. The precipitated movements of the heart, and the inverted action of the stomach have already been noticed. In these facts we have the demonstration, that the brain is capable of transmitting an impression, or action, into the organs placed under the more immediate domain of the ganglionic system of nerves, or the sympathetic; and that this system is not independent of the cerebral organs.

The influences of the passions that have been signified are instant in their production: they result from the commotion, with which the whole nervous system is agitated; and which seems to be a fluctuation of its principle, agent, or energy, impelled with sudden impulses from the central nervous organs, into the whole of the nervous ramifications connected with them. These phenomena are, then, purely nervous, and belong to the category of nervous irritations.

The effects of moral commotions are not, however, limited to the production of mere nervous disturbances, and the phenomena of nervous irritations. Sanguine irritation is occasionally developed, congestions are formed, and inflammation may be a consequence of the incessantly reiterated, or continued action of the moral affections. The depressing passions and sentiments, grief, sorrow, wounded pride, a quick moral sense of injustice, or of suffering unmerited misfortunes, become causes of chronic inflammations in the digestive organs, terminating in the formation of squirri, corroding ulcers, and other varieties of disorganization, and change of structure. The chronic gastritis, of which Napoleon was the victim after a protracted agony, most probably, had this origin, acting in concert with the deleterious agency of the insalubrious climate, to which he was condemned, by the policy of the English government. For, to the profound mortification he experienced in the utter blasting of his schemes of personal ambition and family aggrandizement, to which he had sacrificed the exalted glory of being the political regenerator of Europe, the excessive sensitiveness of his character exposed him to incessant annoyance and vexations from the petty malice of his vulgar gaoler. He forcibly describes his sufferings from this cause,

when he declares, it was killing him with pin thrusts, (coups d'epingles.)

But, if the disturbances excited by deep moral impressions be sufficient to awaken inflammations, they are infinitely more to be dreaded when inflammations already exist. In no part of the management of disease is a higher degree of skill, tact, discernment, and talent required, than in the regulation of the moral impressions, and the government of the emotions and passions of patients, especially in acute and very critical cases. There are moments when existence hangs suspended as by a thread, and which the slightest moral agitation, or the depression of gloomy sentiments, would immediately dissever. This circumstance renders the recovery of the fearful in severe diseases, always difficult, and often is the cause of a fatal issue with them. The disastrous influence of nostalgia has already been noticed; and which can only be remedied, by presenting to the mind the speedy prospect of a restoration to the friends and home, whose absence is so deeply regretted. Care must sedulously be taken in those who are concerned in extensive affairs, to disengage their minds from them, and particularly to conceal, until their recovery, any unpleasant occurrence that may have taken place. I attended a gentleman, whose affairs had become embarrassed, though not suspected, in an attack of fever. He appeared to be rapidly approaching to convalescence, and was sitting up. A disagreeable circumstance in his bank business was imprudently communicated to him; an immediate aggravation of the disease ensued, great distress was brought on, and a fatal result followed in a few days.

An understanding of the effects derived from the passions, of the ill consequences resulting to the organization from their abuses, and the highly pernicious tendency of their excesses over the functions, and the structural constitution of our organs, while it is important to the medical practitioner, and demands from him a constant attention, is not less valuable to the moralist. No motives, in the generality, govern man with a greater force than those which regard his interest, his safety, and his happiness. But the precepts of moralists have generally been too refined for the vulgar comprehension; and too abstract and metaphysical in their rationale to impart to them a sustaining power in the con-

flict with present and pressing temptations. They have not been connected sufficiently with his organism; they have not been, in an adequate manner, made identical with his pains and his pleasures, his happiness and misery, his preservation and his destruction. Morals, in nature, are based on physiological principles. Let it be understood, that Divine wisdom has so ordained, that the abuse of our natural faculties, or *vice*, is not a mere violation of an arbitrary command; that it is the self-infliction of positive injury on the well-being of our organs, and its continuance will jeopardize existence; that it entails not only future retribution, but present punishment; that it involves not only moral suffering, but inevitably produces physical disorders, causes physical pain, even physical tortures, the escape from which makes death a blessing; and there are presented to the mind a combination of motives, appreciable by every understanding, and will be disputed by none, the most powerful that can be framed to fix the determination, fortify the will, and enable it to resist corrupting propensities, and control dangerous passions.

Not less important is it to the physician, and to the moralist, to be aware of the influence exercised by the viscera over the operations of the moral faculties and the excitation of the passions. This was formerly alluded to, as connected with pathology, and is now mentioned chiefly in relation to morals. It is a prolific source of crime, and should be a subject of prominent interest in moral instruction, and the principles of self-government. Irritations developed in the viscera, more particularly the gastric and genital organs, by their sympathetic irradiation on the cerebral organs, bring them into a similar state of irritation, increase their susceptibility to impressions, and quicken their activity. But the association of the viscera is most direct and intimate with the moral faculties, which thus participate the most directly in the morbid irritation of the viscera. In this state, the result of moral impressions is not in accordance with their natural order, but occasion explosions of passion, moral agitations and determinations, that appear unaccountable to those who have not been taught, or accustomed to appreciate, this influence of visceral irritations over the moral faculties. Individuals whose propensities are strongly developed, if they would avoid the commission of criminal acts, let them most cautiously refrain from heating food and stimulat-

ing drinks; and the rule is equally imperative on all, who may be engaged in personal controversies and disputes, which elicit irascible feelings. No one can answer for his actions, or foresee the consequences they will involve, who disregard this precept. Such constantly are surprised, and hurried into the perpetration of an act, of which, at the time, they scarcely have a consciousness. On the examination of culprits, it is a common declaration, when a crime has been committed under the combined influence of angry passions and liquor, though not absolutely intoxicated, that they were not conscious of what they did, and are ignorant of the circumstances that occurred. This is not a pretext, but a truth. The intellectual faculties are dethroned in the raging of the moral commotion; all impressions, feebler than those of the excited organs, are neutralized, or engulfed in the vortex of the passions; and all the energies of the moral and physical being are diverted into one direction, and concentred on one act. Innumerable are the catastrophies and crimes, and inconceivable the amount of human misery, that would have been prevented by the timely loss of a little blood, a few days of abstinence, or even the drinking of cold water.

CHAPTER VI.

Function of Voluntary Movements.

The means of existence, in the superior order of animals, are placed exterior to themselves, and reproduction is reposed in the concurrence of sexes. The power to move the whole, or a part of the body, for the accomplishment of these objects, and to guarantee its preservation, was a necessary provision. This end is attained by the arrangement of the apparatus and function of locomotion, or voluntary movements.

The functions discussed in the preceding chapter, bestow the capacity to perceive exterior substances, to determine their qualities and relations to the organism, to acquire a consciousness of

the wants, to devise the means by which these are to be gratified, and to direct the measures for individual preservation and social government. But they are devoid of executive power, and necessitate a system of organs subservient to their purposes, and adapted to give effect to their determinations. The possession of sensibility demands, of necessity, volition and locomotion: they are always concurrent.

The voluntary movements are executed by muscles, which are subjected to the control of the will. The power to excite the contractions of the muscles is distinct from, though put into exercise by, volition; for the muscles of voluntary movements are often forced into actions without the will, and even in opposition to its dictates. Besides, there are muscles whose contractions are entirely independent of volition, over which it does not exercise the slightest influence; such are the heart and muscular tunics of the alimentary canal and of the uterus: while a third class of muscles, though controlled to a certain extent, and for the performance of special purposes, by volition, are, nevertheless, compelled to obey another power, acting under the instincts, wants, or internal sensations, and which the will cannot prevent when they become imperative; such are the diaphragm, and muscles of respiration, the muscles concerned in defecation, and urination.

The voluntary movements being established for the profit of the organization, under the functions of relation, must be in correspondence with these organs by nervous connexions. Hence the apparatus by which they are effected is complicate, and consists of different kinds of organs. It is composed—*a*, of nervous organs, whose peculiar office is to excite muscular contractions; *b*, of muscles, in whose contractions reside the force to accomplish movements; and *c*, bones, or other solids, the parts requiring to be moved. A slight expositive examination of each, will tend to the illustration of their respective modes of action, relations, and the nature of the morbid lesions, of which they are the seats and the cause.

§ 1. *Of the Nervous Organs of Voluntary Movements.*

The general description of the nervous system was made, and its various offices was designated, previously to treating of the func-

tions of relation.* It may be here repeated, that the anterior columns of the spinal marrow, and portions of the medulla oblongata, are the nervous structure immediately concerned in the production of muscular contractions. The muscles of locomotion, and all those submitted to the will, are held in connexion with these portions of the nervous organs by nerves, and are susceptible of voluntary movements only during its maintenance. When the correspondence between them is destroyed, volition can no longer influence their contractions. That this power does not reside in the brain, is evidenced by the persistence of muscular contractions, after the functions of the cerebrum have been destroyed in disease; after decapitation, which, in some animals, does not destroy movements, as in the tortoise and the viper; and which were observed by Le Gallois in the hare.

In the late experiments performed by Flourens, Magendie, and Serres, with the view to determine the functions of different portions of the nervous structure, the ablation of the cerebral hemispheres was found to produce stupor and perfect insensibility, but the power of motion continued unimpaired.

The nervous organs, in which resides the power to excite muscular contractions, it appears, then, to be very conclusively established, are the anterior columns of the spinal marrow and the medulla oblongata. It is a question, however, that remains to be decided, whether this power is common to the whole of the structure indicated, or is located in a part where it is generated, and merely communicated or transmitted by the remainder. The experiments performed by Flourens, go far to determine a location for this power, which is the medulla oblongata, immediately adjacent to the origin of the pneumo-gastric, or eighth pair of nerves. If a division be made immediately below this point, motion ceases in all the voluntary muscles receiving nerves from the spinal marrow: it remains perfect in those whose nerves proceed from, or above this point. When the division is effected immediately superior to the origin of the eighth pair of nerves, movements cease in the muscles whose nerves are above the lesion, while they remain, in all those supplied by the spinal marrow, below it. The same observations prevail in respect to sen-

* Pages 130, 131.

sation, and, thus, is established the fact previously announced,* that the medulla oblongata is a vital centre, holding all the vital phenomena in immediate subordination.

Voluntary movements are, however, commanded by volition, which is either a distinct intellectual faculty, or, what is not improbable, the operation of a faculty, intellectual or moral, in action, exciting the movements which its determinations may command. Either view supposes the action of a cerebral organ, as the excitant of the nervous power, placed in the medulla oblongata, which, being directed on the muscles, throws them into contractions. Thus, voluntary movements always require, as one of their conditions, the action of a cerebral organ.

The movements demanded by volition, in general, necessitate the simultaneous contractions of different muscles: they must, consequently, be coordinated to accomplish the movement willed. This office, strong probabilities lead to a belief, and which have already been detailed,† may be attached to the cerebellum.

But, that the nervous stimulation of the central organ of the medulla oblongata, or spinal marrow, be directed on the muscles, they must be connected with those organs; and this is accomplished by nerves. The larger portion of these proceed from the anterior columns of the spinal marrow, though some pass direct from the medulla oblongata, and, entering into the muscles, are there distributed amongst its fibres. MM. Prevost and Dumas have shown that the nerves are not lost in, and become continuous with the muscular fibres, but remain distinct from them. The nerve, and its first branches are observed, in muscles, to be arranged in tortuous lines, without fixed direction: while the minute filaments that are given off traverse, invariably, the fibres at right angles, and return to unite again with the same nerve, or to anastomose with an adjoining branch. By this distribution a nerve terminates, in muscle, in the formation of innumerable fine loops; an arrangement entirely distinct from that observed in the organs of sensibility, in which the nervous filaments appear to assume an expansion approaching to the character of a membrane.

The nervous organs of the voluntary movements are thus seen

* Page 200. † Page 202.

to be—*a*, a cerebral organ, exciting volition; *b*, an organ in the medulla oblongata, exciting muscular contraction; *c*, the anterior columns of the spinal marrow, and nerves connected with them, which transmit the nervous excitement to the muscles.

§ 2. *Of Voluntary Muscles and their Contractions.*

Muscles were partially described when treating on the tissues.* The filaments of muscular fibres, of which muscles consist, united by cellular membrane, are intermingled with arteries, veins, lymphatics, and nerves. The primary filaments of muscles have been clearly shown by Edwards, Home, and Bauer, to be composed of globules, corresponding to the uncoloured globules of the blood, connected by an elastic medium. The red colour possessed by most muscles, is not the proper colour of the fibre, but arises from the blood contained in them; for by washing and maceration they become colourless.

The muscular fibres, in repose, are always straight, and each extends the whole length of the muscle, though they have various dispositions in different muscles.

Muscles are not wholly constituted of the above filaments, but, at their origin and termination, are albugineous, or are composed of fibrous tissue, forming aponeuroses and tendons, by which they are implanted into the parts to be moved. The filaments are united to these in a manner not ascertained, yet, with so much firmness, that either may be ruptured, but the two never separate.

The muscles are the active agents of motion, and their power resides in their capacity of contraction. When a muscle contracts, it swells and shortens, becomes hard and rigid in proportion to the degree of the volition. The contraction of a muscle, it has been established by Dumas, Prevost, and Edwards, is the result of the disposition assumed by its fibres. They are observed to bend, and be inflected into angular zigzags in regular alternation; the flexion being effected at those points where the fibre is intersected by nerves. When the action of the muscle ceases, it becomes immediately relaxed, the zigzag disposition disappears, and the fibres resume their pristine straightness.

* Page 74.

The causes that give to the muscular fibres this peculiar arrangement, when excited into action by volition, by galvanism, by mechanical irritants, or other agents, is not determined. The French physiologists, previously cited, are disposed to attribute this phenomenon to two currents of galvanic fluid, or nervous power, which they regard as nearly the same, attracting each other. This explanation is, however, no other than mere hypothesis, and wants the evidence of positive facts.

Muscular contraction is attended with a peculiar sound, readily perceptible, by placing a stethoscope, or a cylinder of light wood, over a muscle, and applying the ear to it, while the muscle is made to contract. It is also the deep rumbling sound heard when the ears are stopped with the fingers: and the roaring sound that appears to issue from a shell held to the ear, proceeds from the same cause.

By the continued action of muscles, their circulation is augmented and excited; those most exercised acquire the deepest colour, and their nutrition is more active. In contracting, the blood is expressed, for the moment, from their fibres, and propelled more rapidly into the veins. Hence muscular exertions increase the celerity with which the blood is returned back to the heart.

The capacity of a muscle for contraction, is connected with the integrity of its circulation: the presence of arterial blood is a necessary requisite, that it may possess the aptitude to experience the stimulation of nervous influence. A ligature applied to the vessels of a muscle, paralyses it with as much certainty, and, even, in less time, than the section or ligature of its nerves: and its susceptibility to contract by the stimulation of galvanism, is still more completely destroyed.

The susceptibility to contraction, from the excitement of the nervous organs, or other causes, is inherent in the muscular fibre: it is the irritability of Haller, and the sensible organic contractility of Bichat. Its exact nature is not known; but there appears to me an impropriety, in placing it on the same line with the vital forces, as has been done by Haller and Bichat; it belongs rather to the functions. Contraction is a functional act executed by muscular fibre, and put into action by appropriate agents, in whose deficiency it is quiescent. In this respect, it corres-

ponds with sensibility, and with the senses; with all the functions, the offices executed by different organs, or excited into action by particular or specific agents. A vital force is incessantly in action, for, if withdrawn, the vital phenomena depending on it are destroyed. But muscular contraction may be suspended indefinitely, as in paralysis, without interfering with, or suspending any vital process or action. Its characters are those of a function, and not of a vital property.

Long-continued exercise impairs this faculty in muscles; fatigue, or a sense of lassitude, which may be regarded as muscular pain, is induced; their contraction is with difficulty excited, and is executed with feebleness. The exercise of muscular activity always necessitates repose: and hence, voluntary actions, like all the functions of relation, are intermittent. These are additional circumstances tending to establish the fact, that muscular contraction is a functional act, and not a vital property.

On the cessation of life, the muscles contract and grow rigid. This state begins to show itself within an hour or two after death, and continues to augment for a period of twenty to thirty hours. As soon as decomposition commences, they become relaxed. These circumstances sometimes acquire importance in medical jurisprudence. On a late notorious trial for murder in Kentucky, when it was generally suspected an intention existed to screen the criminal, the judge assigned, as one of the reasons for setting aside the verdict, and granting a new trial, that the body was not stiff, and, consequently, could not have been dead some days, but must have been recently deprived of life. Whereas it was a proof that the murder had been committed several days previous to its discovery.

The same causes that produce the stiffening of muscles, occasion coagulation of the blood; both processes have a strong analogy to each other; and, thus, is furnished an additional evidence, that the muscular fibre is constituted of the globules or fibrin of the blood—and that it is this fluid in a concrete state.

Muscles cease to contract when their connexion with the nervous centres is dissevered: their capacity for contraction notwithstanding continues, and may be excited into action by irritating the muscular fibre, or the extremity of the nerve supplying a muscle. This power is, then, independent of the nervous organs;

they merely furnish the appropriate stimulant exciting it into action.

Contraction of muscular fibre is dependant on the following circumstances; *a*, the integrity of its structure; *b*, the presence of arterial, or oxygenated blood in its structure, requiring an incessant renewal; *c*, nervous, or other excitation.

§ 3. *Of the Bones.*

The two preceding portions of the apparatus of voluntary movements are the active agents of their production. The portion under consideration is passive, and is found only in a part of the animal creation. It constitutes the skeleton, and is the hardest part of the body, serving as its base and support, and for the attachment of other organs. Two offices are assigned to the osseous structure. The first is to form a protection to important organs, which it encloses in cavities, as the brain and the thoracic viscera; and the second is to serve as levers in locomotion, and for the implantation of the muscles by which the body is moved.

The bones are formed of a cellular and vascular tissue, into whose composition enter, vessels, lymphatics, and, as M. Duveril and Mr. Swan have shown, nerves; and which is encrusted with saline and earthy matters. On the exterior they are covered with a fibrous tissue, called periosteum; the interior of the long bones is a canal lined by a vascular membrane, named medullary, secreting an oily fluid, called marrow, whose use is not well known. In the spongy bones having no canal, a similar fluid is exhaled into the cells they contain within them.

In a healthy condition bones do not manifest sensibility; but when inflamed, and the order of their nutritive actions are, consequently, changed, they undergo a complete metamorphosis in their structure, and they acquire an acute sensibility.

The bones are connected together by an arrangement, which is termed articulation and joints. In some instances it admits of motion of various degrees of freedom; and in others the bones are immoveably attached. The articulation is never made by the immediate juxta-position of the bones, but by the interposition of a particular substance, called cartilage. The bones are also further united, and their articulations strengthened and completed by va-

rious other media of connexion, as ligaments, fibro-cartilage, fibrous capsules, and synovial membranes. The capsular ligaments of the different joints have been shown by Dr. Godman to be a continuation of the fascia covering the muscles.*

The bones consist of gelatin combined with phosphate of lime, from which they derive their solid structure. The cartilage and fibro-cartilages, connecting them together, are of similar composition, but possess less of the earthy salt. The ligaments and capsules of the articulations, like the periosteum, or exterior covering of the bones, belong to the fibrous tissue.

The interior of the joints is lined with a membrane, having a strong resemblance, as to form, structure, and functions, to the serous membranes, and has been named by Bichat synovial; it furnishes the lubricating fluid of the joints, called synovia.

By this arrangement the bones, forming the skeleton, and imparting the requisite solidity, to give support and defence to the mass of the organs, are capable of being moved on each other, in various manners, by the forces applied to them.

§ 4. *Conditions and Production of Voluntary Movements.*

From the preceding examination, voluntary movements are shown to be accomplished by different organs, each executing a special office, and the whole concurring to the same end. The organs that are active in this operation, are a cerebral organ exercising volition, and directing the particular movements; especial nervous organs having the power to excite muscular contractions; and the muscles executing contractions.

That voluntary movements may be executed, two conditions are required; the first is, the natural state of each of these structures; and the second, the maintenance of the connexion between them.

A pathological condition of the brain, suspending the intellectual faculties; or, their temporary suspension from excessive inebriation, and the narcotism of opium, by preventing the exercise of volition, render these acts impossible.

* Anatomical Investigations by John D. Godman, M. D. Philada.

A similar state of the organs of the medulla oblongata, by destroying the action of the nervous exciting power, renders the will impotent, and the contraction of the muscles cannot be effected. This occurs in some cases of palsy, when an effusion of blood exists in this part of the encephalon.

The muscles themselves may also be rendered incapable of contraction by a pathological state. Thus, when highly inflamed, their contractions cease, and movements are not executed.

The destruction of the second condition, occurs in various morbid states of the anterior columns of the spinal marrow, and the nerves proceeding from them to the muscles; or by their division, &c. all of which cause paralysis in the muscles, by interrupting the action of the nervous organs on them.

In the production of this order of movements, the action of the cerebral organs, or volition, bears the first rank. Two opinions have been promulgated in respect to this intellectual operation. Metaphysicians have uniformly regarded volition as a faculty, of the same nature, and on the same level with the other faculties of the intellect. Some physiologists entertain the same doctrine, as to the separate and independent character of volition, believing it to be exercised by a special organ; but the more common, and, as I conceive, correct opinion of this school, refers it to the activity of the organs.

Volition, in this view of its production, is a result of the operation of any of the faculties; it is the determination of that whose activity at the time is most exalted, whose especial organ is most excited, and whose power is directed with greatest energy on the organs in the medulla oblongata, excitative of muscular contractions.

In this manner are commanded the actions in harmony with the predominant faculty, procuring its gratification, satisfying the desires it had created, and allaying the excitement of its organ. Volition is no other than the supremacy of a faculty or organ in directing the actions. They are, consequently, governed always by the physical state of the organs. It is now easy to understand, in a moral point of view, the vast importance of regulating the moral faculties, of preventing the too frequent exercise of the propensities of vicious tendency, and to avoid the formation of improper habits. Every organ is invigorated by the fre-

quent repetition of its actions; and those most developed, and whose energy of action is most intense, are masters over the others. In those of the intellect, they impart the general disposition, or form the character of the individual. Whoever would wish to escape the commission of improper acts, let him avoid placing himself in situations where the propensities exciting them will be strongly called into action, unless he has opposite propensities, or the higher faculties of sufficient energy to counteract, and that have been disciplined to subdue them.

From no source has, probably, flowed more moral disorder, or any cause been more productive of individual ruin, than the belief, that the will is an independent and controlling power, capable at pleasure of mastering the passions and propensities, and directing of itself the government of our actions. Deluded by this mistaken confidence in self-government, the passions are permitted to acquire an ascendancy over the faculties, and too late are they found to be uncontrollable, though easily commanded, had their excitement in the commencement been avoided. Numerous are the individuals who have, in this manner, been surprised into crime, and the perpetration of acts, they had believed themselves incapable of committing, and against which they had supposed themselves completely fortified. The petition embraced in the Divine prayer, "keep us from temptation," is founded on a thorough knowledge of human nature, and is a comprehensive precept of morals.

§ 5. *Pathological States of the Organs of Voluntary Movements.*

The voluntary movements may be pathologically affected in any portion of the different apparatus concerned in their production. These morbid affections are various, and will be most clearly understood as exhibited in the different organs of voluntary motion.

a. Nervous Organs.

In that degree of excitement of cerebral organs, and activity of passions, constituting Fury, volition may be regarded as in a

morbid state, for it impels to actions having no correspondence with the impressions actually made, and which the individual cannot govern or command.

In ecstasy, formerly noticed, a single organ appears to be in a state of high permanent excitement, reducing the mind to a single sensation and idea, and producing a fixed volition, somewhat analogous to a spasmodic action, maintaining the body in an immoveable position, with rigidity and contraction of the muscles.

Catalepsy is an affection belonging to this order. Volition, and the exercise of the intellectual and moral faculties, in this disease, appear to be in a torpid condition. The position given to a limb is retained immoveably, however awkward and painful it may be; sensation is suspended, and volition is entirely mechanical.

The organs in the medulla oblongata, excitative of muscular actions, will produce those actions whenever they are irritated. The same observation is equally applicable to the spinal marrow, as it respects the muscles supplied with nerves below the point where the lesion exists. Thus, any mechanical irritation of either of those structures causes convulsive motions in the muscular system of relation. But they are liable to become involved in the irritations developed in different parts of the economy, and transmitted to them by the nerves. When these irritations possess a pathological intensity, convulsions and spasms are produced. The first, or convulsions, are caused by irritations awakened in the medulla oblongata, and, then, are accompanied with more or less of disturbance in the cerebral organs; the last, or spasms, result most generally from the spinal marrow, and are unattended by any affection of the cerebral structure, its faculties acting in a natural order.

The voluntary movements, in this manner, are thrown into violent action without the concurrence of volition, or of any of the psycological faculties. Individuals of a nervous temperament, whose stomachs are in a state of irritation, by taking indigestible food, or drinking ardent spirits, will often have their muscular system excited into violent efforts, approaching to convulsions. They possess, however, a perfect consciousness of their actions, but are incapable of commanding them, or restraining the violence of their proceedings: in this the affection differs from convulsions. An intense and distressing sensation is experienced in the epigastrium.

In children convulsions are often excited by indigestible food, by worms, and by fecal matters, in the stomach and intestinal tube. The irritations excited on the mucous tissue of the alimentary canal, are irradiated on the medulla oblongata and cerebrum, whence arise the disordered movements of the muscular system.

Epilepsy has a similar origin. The paroxysms of the disease are immediately excited by irritations originating in different organs, most commonly the stomach and alimentary canal, or genital apparatus, and reflected on the encephalon.

Hysteria belongs to the same order of affections, and has nearly a similar mode of production. The cerebral organs are, however, less deeply involved, and consciousness is not entirely suspended.

When the structure of these organs becomes seriously affected by disorganization, or compression from effusion, their functions are destroyed, and paralysis of the muscles ensues. The stimulation of volition, either is no longer experienced by the excitative organs of the medulla oblongata, or, if the lesion exist in the medulla spinalis, the stimulations of those organs is not trans mitted. The muscles in paralysis have not suffered in their capacity for contraction; they do not act, solely because they do not receive the nervous influence required for that purpose.

The nerves conducting the nervous stimulations to the muscles, are not often separately affected, so as to prove a source of disease, in the voluntary motions. Cramps, which are spasms of a single muscle, or of the muscles of a single limb, most probably depend on an affection of the nervous cords connecting the muscles with the nervous centres. They may depend on the same condition of the nerves of motion, that neuralgia does on the nerves of sensation.

b. The Muscular Organs.

The pathological condition of the voluntary muscles, seldom proves a cause deranging the locomotive movements. So little are they exposed to receive aggressive impressions of any kind, the range of their morbid affections is restricted to narrow limits. They are subject to occasional inflammations. It rarely commences in this structure, unless proceeding from direct violence,

but most commonly is extended to it from adjoining tissues. When inflamed, muscles are incapable of executing contractions.

The principal obstacle to the performance of locomotive movements on the part of the muscles, proceeds from their intimate association with the fibrous tissue, covering them as fascia, or connected with them as aponeuroses. This tissue is the frequent seat of inflammations, constituting rheumatism, especially in the ligaments of the joints. These, Dr. Godman has shown, are continuous with the fasciæ of the muscles, and, hence, the ready transmission of rheumatic inflammation to them from the articular ligaments. In this state muscular contractions cease, or are very imperfectly executed.

c. *The Bones and Ligaments.*

The integrity of the bones and articular connexions, is indispensable for the performance of locomotion. Fractures and dislocations entirely incapacitate them for this object. The bones are besides attacked with inflammation; they become vascular and sensible; they soften, and sometimes a portion of them dies. The nutritive action is in some instances defective, the earthy part is not formed in its due proportion, the gelatin is in excess, and the bones lose the firmness requisite for their proper office. This state is rachitis or mollities ossium.

Inflammation attacking the cartilages, the ligaments, or the synovial membranes of the joints, produces incapacity for locomotion. This is seen in gout and rheumatism; when the last membrane is affected, a great accumulation of fluid occurs in the joint.

§ 6. *Of the Manner in which Voluntary Movements may act as Pathological Causes.*

That the exercise of the nervous organs of locomotion, ever proves a source of disease to them, is unknown, and it is probable, the excitement from the performance of their functional acts, in locomotion, is never sufficient to become morbid. It is nevertheless true, that anger and rage increase in violence with the gesticulations and movements expressing the feelings; and soon

subside when the body is kept quiescent. This may in part be the effect of increase of excitement by the exercise of the nervous organs of locomotion.

Muscular contraction is attended, like every other functional action, with excitement of the organic actions. The circulation is rendered more active, the nutrition of the muscles more vigorous, and they acquire the fullest development of which they are susceptible. When the exercise of the muscles is prolonged, the limbs feel stiffened; a sentiment of lassitude is experienced; the contractions of the muscles are enfeebled, and performed with difficulty. These disappear on repose, which they strongly solicit. But, if the movements should be excessive in violence and duration, the increased determination of blood, and augmentation of excitement, will eventuate in the inflammatory state; the functions of the muscles will, then, be suspended, or impossible, and even suppuration may ensue. From the irritation experienced in the articulations, rheumatism, with other affections of the joints, are induced. Such are the *local* consequences of excessive muscular exercise.

General effects follow often from the same cause. Fever is excited, requiring at times sanguine depletion to subdue it. The nervous system is exhausted, and inflammation of the viscera established, more especially if stimulants and a full alimentation are taken freely during the period of the exercise, or immediately succeeding it.

Exercise of the voluntary muscles aggravates all acute inflammations, by the increased activity imparted to the circulation. In the irritations and structural derangements of the heart, and the pulmonary organs, it is of marked disservice. By returning the blood rapidly back on the circulating apparatus, it increases the labour of the heart, and accumulates the blood too rapidly in the lungs, in which the area for its transmission is considerably reduced. The injudicious recommendation of exercise in the diseases of the thoracic organs, I have known to be productive of great distress to the patient, and of aggravation to the disease.

Violent muscular exertions, continued for a considerable period, by the velocity and force imparted to the circulation, and the consequent hurried action of the heart, excite inflammation in that organ, terminating in hypertrophia, enlargement, or other

derangement of its structure. I have met with two instances of organic disease of the heart, brought on by over-exertion in working engines for the extinguishment of fires. Other organs suffer from this cause, and hernias, or the protrusion of some of the abdominal viscera from that cavity, originate in this manner. The muscles themselves are sometimes ruptured by excessive efforts; this has occurred to the diaphragm, and death been the consequence.

§ 7. *Of Exercise as a Means of Maintaining Health.*

Exercise of the muscles is the most effective of the resources of hygiene, when directed on proper principles, and alternated with repose. The general effects on the health, accord with the numbers of the muscles brought into action, and the energy of their exercise. The excitation of the organic actions is extended throughout the economy, and all the nutritive functions experience an evident invigoration. No other mean more effectually counteracts the disposition to the formation of congestions, and a sluggish circulation of the fluids, particularly in the viscera.

A distribution of the fluids amongst the organs, proportioned to their functions, and activity of the organs, graduated to their powers, are the conditions for the enjoyment of health. Regulated exercise accomplishes these objects. The continued excitement of any of our organs, disposes them to diseases of irritation, deterioration of their structure, and disorder of function; while it places some other apparatus in a reverse position, by abstracting its fluids, and diminishing its excitement. The irregularities induced in this way are rectified by appropriate exercises. The muscles, when in action, operate as a diverticulum to the interior viscera where the sanguine fluid has accumulated, by their excitement attracting into them an additional amount of blood; and, at the same time, their action bestows new vigour on the circulatory movements of the fluids.

Exercises are active, passive, and mixed: each possesses its peculiar advantages, and is to be employed according to the indications attending the individual. The constitution, the temperament, the predisposition to disease, the actual disease, the ir-

regularities and defects of form intended to be redressed, all exact particular modes of exercise.

For these reference must be had to works on hygiene and gymnastics. I shall here confine myself to the two following remarks; 1st, that the practice of corsetting young girls, by condemning the muscles of the back, intended to support the spine, and the muscles of the chest employed in respiration, to a state of almost total inaction, prevents them from attaining the size or energy requisite for the performance of those offices. The necessary consequence is, that curvatures of the spine result from the bones composing it losing their natural support, and the back becomes crooked; the chest is prevented from expanding; and the lungs and heart, being crowded and compressed, cannot execute their functions in a manner requisite for the maintenance of the healthy actions of the organs, and are themselves subjected to disease. To this practice is to be ascribed no inconsiderable amount of the rapid increase of pulmonary affections, and diseases of the heart, affecting females in a most undue proportion; and of the deformities observed in fashionable circles in the large cities of Europe and this country. At least one female in six, at this period, is in the condition I have described, and relies on artificial means to conceal the defects, originating in an absurd and tasteless fashion, acting in opposition to nature, destroying the symmetry of form, and the grace of motion, that can emanate alone from the full development of the frame, and the unconstrained freedom of its movements.

2d. When curvature of the spine has been brought on by feebleness of the muscles of the back, exercises adapted to bring them into action, are infinitely more efficacious for its removal, than mechanical beds, and other mechanical contrivances, in which this essential requisite is overlooked.

CHAPTER VII.

On the Expressions.

The wants of the physical organization, and the helplessness attached to certain stages of existence, and which accidentally may supervene, producing a dependency upon external aid, created the necessity of a mutual communication between animals. All animals are, consequently, endowed with the faculty of communicating, in various modes, to those of their own species, and, in a certain degree, to those of other species, a knowledge of their wants, and thus inviting the extraneous assistance indispensable to their gratification, and often to individual preservation.

To most beings power is bestowed to provide for their protection, or the means of their subsistence. But this power is exercised frequently at the expense of others; and, under the government of violent and destructive passions, may prove hazardous to the existence of those against whom it may be directed. That those whose safety is thus threatened, should be placed on their guard, and receive timely warning of their danger, is an additional reason, that the internal emotions, or excitations of the passions, should be announced by external signs, exhibiting a hostile, a malevolent, or benignant intention, ruling the interior and secret sentiments.

The operations of the intellectual faculties evolving thought, depend on the capacity of its communication to others. Without this power those faculties would be useless, society could have no existence; its progressive improvement, and the amelioration of the human race, to be accomplished by the advancement of knowledge and true wisdom, could not be effected. Man would never rise above the instinct of the brute.

For the completion of the preceding important, and indispensable purposes, have been provided, the functions of the expressions, or the diversified phenomena outwardly manifesting the internal sensations and sentiments, in a manner to be comprehended by others.

In man, more than in any other being, are united the circum-

stances necessitating the functions of the expressions. The periods of his natural feebleness are the most protracted, his more complex and finished mechanism subject him to suffer the most frequent disabilities, and, consequently, his state of dependency is the most complete; his wants further are the most numerous, while his power is more formidable, his passions more varied, intense, unyielding, and destroying, than are those of any other animal. To him alone belongs also the capability of forming intellectual abstractions of elevated order, requiring artificial signs for their communication. In man, accordingly, the expressions exist in the greatest number, diversity, and highest perfection.

§ 1. *The Organs, and the Production of the Expressions.*

The expressions differ from all the other functions in being composed of different order of phenomena: they are of dissimilar characters, and are executed by organs having no analogy to each other.

The expressions consisting of external phenomena, indicative of internal sensations and sentiments, or the moral affections, derive their immediate origin from the operations of nervous organs. Each emotion and passion, the action of the moral faculties, possesses the power to influence certain muscles, and to occasion particular movements, and its exercise is, consequently, attended with especial signs perceptible by the senses.

The nervous organs interested in the production of the expressions are; 1st, the organs of the intellect, and of the passions, or moral faculties; 2d, organs excitative of certain muscular contractions; and 3d, particular nerves.

The impulse commences with the first, but they cannot alone excite the muscular actions immediately causing the phenomena of the expressions. These proceed from other organs, in a manner perfectly analogous to the arrangement indicated in the production of voluntary movements, and which are seated in the medulla oblongata. To these organs are conjoined certain nerves, additional to the nerves belonging to the sensations, and the voluntary movements, through which are impressed modifications in the actions of the muscles, whence are produced the expressions, corresponding to the internal sentiments.

The expressions consist in exterior signs. Some, composed of muscular movements, are presented to the sight; others consisting in sounds, are addressed to the hearing. The first comprises the changes and variations in the countenance, or what is termed physiognomy, and the gestures: the last are modifications of the voice or phonation. A short notice of each is necessary to illustrate their connexion with the pathological state.

§ 2. *Of Physiognomy.*

The human face is, as it were, a mirror where is reflected the passing emotions of the soul. Few are capable of commanding their sentiments, the actions of the moral faculties, so absolutely, as not to reveal, in the expression of the countenance, the character of the internal feelings. Some are gifted with the power of calling those faculties into exercise, and depicting their expressions in the face, the gestures and the voice, at any moment, and suitable to the occasion. In this power consists the highest order of histrionic talent.

As an organ of the expressions, the human face far surpasses that of every other animal. It is much less occupied with the organs of taste and smell; presents a larger surface; is more exposed, being less covered with hair; and, by its elevated front, possesses a more majestic and imposing character.

The eye, that has been called the organ of the soul, is its principal feature, and manifests in its movements the state of the mind; while the secretion of tears is a striking phenomenon of expression.

The mouth and the nose, connected with respiration, are somewhat modified by the state of that function, and thus exhibit the changes induced in it, under the influence of violent emotions.

The conformation of the face, by the presence of so many organs, presents various prominences, forming features or lineaments; and it is moreover endowed with great mobility. This extreme mobility of the face is imparted by forty-five muscles situated beneath its skin—twenty-two on each side, and one on the median line—whose contractions, as they are excited by various emotions, produce innumerable modifications of the linea-

ments of the face, and exhibit every variety, even to the lightest and most delicate shades of expression.

The muscles of the face execute different offices. They assist in the prehension of food, mastication, and speaking, and in these acts bear a perfect resemblance to the muscles of voluntary motion, being directed by specific volition. They also concur in the respiratory efforts, when these are violent; and they obey the impulses of the moral sentiments and passions, denoting them in the expressions, or modifications of the features. These last movements are of the nature of the instinctive muscular movements, for they do not require specific or conscious volition for their production; but, on the contrary, are irrepressible by volition, or the exercise of other faculties, which are excited at times in the intention to oppose them, and to prevent the expression of the feelings.

The facial muscles are endowed with the capability of performing these different offices, in being supplied with different nerves. The anterior branch of the fifth pair, analogous to the spinal voluntary nerves, is distributed to them, and causes in them voluntary motions. They are, in addition, furnished liberally with the portio dura of the seventh. This last, Mr. Charles Bell has most clearly determined, to be a nerve of expression and of respiration,* in a work, embodying a series of researches, models for similar investigations, and which opened views on the nervous system, rapidly conducting to a full knowledge of its functions.

The division of this nerve, or its structural lesion by disease, invariably paralyses the facial muscles, as it respects expression and the respiratory acts, while they still retain the power of obeying volition, and performing the first class of movements. When the divided nerve is subjected to galvanic irritation, the movements of expression are produced, similar to those directly emanating from the moral influences.

Through the medium of this nerve, the muscles of the face are placed in immediate relation with the organs of the intellectual, and especially the moral faculties, representing in their motions, with fidelity and truth, the interior workings of the mind. As they are attached to the features, these are necessarily modified

* Exposition of the Natural System of the Nerves.

by their frequent and powerful actions; and, at the same time, they leave indelible traces by the lines they form in the skin: hence the countenance receives a faithful impress of the character.

The mouth and the eye are the features representing the greatest number of the passions, and are the most perfect in their expressions. The extreme mobility of the mouth adapts it to mark a variety of feelings, and to disclose the indication of the disposition. The eye, from its numerous muscles, is capable of movements in every direction, or may be rendered fixed in its position. Its movements are governed by the passions, and especial directions are given to them, by certain moral sentiments.

The expressions of the eye are not imparted to it by the seventh nerve, as they are to the face, but by separate nerves. The third pair, or motor oculi, excite three pairs of the recti muscles that fix the eye, and give it steadiness in the attention of abstraction, and protrude it in the earnest gaze of some of the more violent emotions. The fourth pair, or abducens nerves, supply the abducens muscles; these turn the eyeball outwards in the attention of suspicion, and express that feeling; or, by acting in junction with the recti muscles, they retract the eyeball into its orbit, in envy, jealousy, and the scowl of malignant hatred. The sixth, or trochlear nerves, animate the trochlear muscles, by which the eye is pressed slightly downward and inward, or brought forward, and which give the expression of surprise, joy, terror, &c.

Besides the movements impressed on the eye by the passions, it undergoes changes within itself, that display, in a striking manner, the fluctuating affections of the soul. From the eye may be divined the interior sentiments, which it expresses too distinctly to be misunderstood; and it even bears the stamp of the character. Of this circumstance, Shakspeare, whose observations, drawn from nature, are maxims of truth, was fully aware:—

> Which is the villain? Let me see his *eyes*,
> That when I note another man like him,
> I may avoid him.
>
> *Much Ado about Nothing.*

The skin of the face manifests by the changes it experiences, the phenomena of the expressions. The mental emotions and

passions powerfully affect its capillary circulation, causing it to flush suddenly with blood, or to be abandoned by that fluid. Hence the blush of shame, the glow of indignation, and the pallidness of fear.

The face, from the preceding circumstances, possesses most perfectly the faculty of expressing the operations of the moral faculties. It corresponds so closely with those faculties, by its nervous arrangements, as to be the external demonstration of the internal sentiments: it is the representative of the inner man. The expression of the face is not limited to the sentiments and passions, but exhibits also the sensations. Thus pain causes various distortions and violent contractions of the muscles of the face, most vividly depicting the suffering endured; while pleasure lights it up with animation, or imparts the tranquil and satisfied expression of enjoyment to the countenance.

The gestures, or the movements, and attitudes of other portions of the body, are significant of the internal sentiments and moral affections, and thus manifest the phenomena of the expressions.

The position, the attitude assumed, the progressive motion of the body, and the movements of particular portions, are all indicative of intellectual and moral excitements, or of particular emotions or states of mind. The proud, the haughty, and independent, may be immediately recognised by their carriage from the humble, lowly, and depressed. The irascible gesticulate with vehemence, and move with rapidity; the peaceable are quiet in their deportment, and slow in their movements.

The muscles of the neck, and the superior part of the chest, are supplied with a system of nerves, independent of, and different from those of voluntary motion. They are the phrenic, the superior respiratory, or spinal accessory, and the inferior respiratory nerves. These, with other nerves, having similar offices, arise from a track of medullary matter situated on the side of the medulla oblongata, and extending downwards. These nerves excite the muscles, to which they are distributed, to aid in the respiratory acts, when circumstances require increased efforts. It is through them also that emotions and passions of the mind influence respiration. Thus, in some passions, it is quickened, irregular, and short; in others, slow and profound. It is singularly affected in

laughing, gaping, sighing, and sobbing; phenomena peculiarly striking, and demonstrative of moral impressions.

These muscles, independent of their connexion with respiration, express particular sentiments by the movements they produce. The head nods in assent; gives the negative by its shake; and the shoulders are elevated to express a contemptuous indifference and resignation.

In this manner the whole body, as well as various of its compartments, concur in the expressions, or the revelation by outward signs of the internal sentiments or state of the soul.

§ 3. *Connexion of the Physiognomy and Gestures with a Pathological Condition.*

Physiognomy, as delineating the character, and disclosing the internal sentiments and workings of the passions, has always been a favourite subject of the study and attention of artists, poets, moralists, and philosophers. Lavater attempted to erect it into a science. He was deficient in sound physiology; he was unacquainted with the medium of correspondence between the organs of the psycological faculties and the muscles of the face, whence a positive provision exists for the development by external signs of internal feelings. The law of correspondence, or analogy of organs, had not then been established, by which a positive deduction of the character of an organ or faculty may be formed from another. His system is, consequently, defective. It does not repose on a durable basis founded on principles drawn from nature, but consists in a series of empirical observations, derived from his personal experience, and are mere evidences of his acuteness and sagacity.

To the physician moral physiognomy is not without interest, importance, or utility in his profession. But medical physiognomy, intimately associated with the diagnosis and prognosis of disease, is an object meriting particularly his cultivation. Numerous affections of the internal organs communicate peculiar expressions to the countenance, instantly detected by an experienced eye, and enlightening the physician as to their precise condition.

The expressions, it cannot be properly said, are themselves the subjects of disease, but they are more or less affected in the mor-

bid states of the economy, and become important as symptoms, furnishing signs indicating the seats of lesions.

From the preceding investigations, it is obvious that the affections of the propensities and sentiments will be designated by their outward representatives, the physiognomical expressions. It is also apparent, that whatever will destroy the connexion of the portio dura of the seventh pair of nerves, with the medulla oblongata, will paralyse the muscles of the face in respect to the expressions and the respiratory actions. Thus tumours at the base of the brain, or in any part along the course of this nerve may produce this result. I saw a patient who complained of violent pain in the left ear, with head-ache, and some tumefaction about the angle of the jaw. In a few days the left side of the face was paralysed for the movements of the expressions. Smiling or laughing produced distortion, the left side of the mouth and face remaining immoveable; yet the lips could be moved by volition, and the sensibility was unimpaired. The different offices of the nerves of the face afford a clear solution of these phenomena.

The pathological signs furnished by the physiognomy are numerous. They are derived from the colour of the skin, the contractions of the facial muscles, the expression of the countenance, and its state of repletion or fullness. This is not the place to enter into the details of each; they belong to diagnostics and semiology. I shall here confine myself to remark, in a general way, that the eye gives the clearest and strongest indications of the state of sanguine irritation of the brain; and the mouth, and lower portion of the face, manifests by its expressions the diseases of the thoracic viscera and stomach.

§ 4. *Phonation or Voice.*

The expressions depicted in the physiognomy, and exhibited by gestures, are addressed to the eye; others are made known to the sense of hearing, and are communicated by the voice, and the modifications it is made to undergo.

Simple as the voice, and its modifying expressions may appear to those who have not reflected on their formation, their production requires a very complicated apparatus.

A brief notice of the organs of the voice, the mode of its pro-

duction, and that of its modifications, becomes necessary to comprehend the physiological and pathological phenomena they manifest; and that present themselves to the attention and investigation of the medical practitioner.

§ 5. *Organs of the Voice.*

Sound, constituting voice, is an effect of a physical property of air, or its capacity of vibrating. Accordingly, the apparatus of the voice is adapted to this property, bringing it into play, as in the organs of hearing and seeing, attention is paid in their structure to the physical properties of sound and light.

The apparatus of the voice comprehends two series of organs; the first, arranged to produce the physical conditions on which it depends; the second, to impart the vital movements and conditions that give effect to the first.

The organs of the first series are, the larynx, the proper organ of the voice, the trachea and pulmonary organs, the muscles of respiration, and the fauces, mouth, and nares, forming the vocal tube. The last series are nervous organs.

The larynx is constructed on the principles of a musical instrument. It is a cylindrical tube, somewhat of the shape of a reversed cone, composed of separate cartilages moveable on each other, and placed on the summit of the trachea. At its upper extremity is formed a chink or narrow aperture of a triangular shape, called the rima glottidis, made by two ligaments, the inferior vocal cords, elastic, fibrous, and vibratile, against which the air in expiration strikes in the production of the voice.

These ligaments extend from the bases of two small cartilages, called the arytænoid, articulated loosely on the posterior of the cricoid cartilage, so as to have free motion. The tension or relaxation of these ligaments, and the greater or less extent given to the opening of the rima, influence the voice.

At the superior part of the larynx, behind the base of the tongue, is a fibro-cartilage of an ellipsoid form, named the epiglottis. It serves to close the glottis in some movements, but it appears principally to be intended to render the larynx more perfect as a musical instrument. Without it the voice, when swelled to a certain pitch, would be liable to break suddenly into a higher

note, as was observable in the clarinette, until this defect was remedied, in that instrument, by placing a tongue of elastic substance above the reed acting like the epiglottis, and breaking the current of air.

The larynx is capable of being moved in whole or in part. It is elevated or depressed by the muscles that act in a similar manner on the os hyoides and pharynx. By this means the vocal tube is shortened or lengthened, modifying the tone of the voice; the depression producing grave, the elevation acute notes.

Several muscles are provided for the partial movements that occur in the larynx, moving its cartilages on each other, and enlarging or diminishing the rima glottidis. One of these, named thyro-arytænoidean, extends from the thyroid to the arytænoid cartilages on each side, and executes an important office in the formation and modulation of the voice. The vocal cords, according to Dutrochet and Magendie, are not in reality ligaments, but aponeuroses, belonging to these muscles, which they cover. Hence the contractions of these muscles directly act on the air passing through the rima.

The larynx is lined throughout by mucous membrane, continuous from that of the mouth above, and that of the trachea below. It is very resisting, and contains cryptæ, furnishing a mucous, lubricating fluid. The alteration of this membrane by disease, as its inflammation, unusual aridity, thickening, or its simple turgescence, occasions decided alteration in the voice, and sometimes aphonia, more or less complete. From acquiring an œdematous state, or by the effusion on its surface of coagulating lymph, the rima may become obstructed to a degree threatening suffocation.

The trachea, and the pulmonary organs, conduct to the larynx, and supply the air requisite for the formation of the voice. No animals possess voice properly that have not pulmonary organs. The lungs, in the phenomena of the voice, act as the bellows to the organ, and the bag in the bag-pipes. The voice depends as to its powers, fullness, and extent, upon the volume of these organs, and the quantity of air they furnish. In phthisis pulmonalis aphonia frequently occurs, from the diminished capacity of the lungs, by the development in them of tubercles.

The muscles of respiration, propelling the air from the lungs, are agents in the production of the voice. The power of the mus-

cles, by the force given to the expiratory effort, regulate its strength and extent; and, being governed by the will, bring the voice under its dominion. In extreme muscular debility the voice is faint, and almost suppressed from the feebleness of the respiratory actions, and the incapacity to expel the air with force through the larynx.

The fauces, mouth, and nares, or the vocal tube, are the last portions of the vocal apparatus. Through them the sound of the voice is propelled, and, in its course along these passages, is modified in its tone. This is shown in the effect caused by closing the nostrils, by their obstruction from a polypus, or their inflammation, when it acquires what is called the nasal sound. Defects in the palate most seriously injure the voice, and, when considerable, render its musical and articulated modifications almost impossible. The interior of the mouth, the tongue, the lips, and especially the opening of the mouth, all produce an effect over the tone of the voice.

The nervous power animating the organs of the voice, emanates from the medulla oblongata. The respiratory system of nerves concurs in the movements producing and regulating the voice. But the nerves on which more immediately depends the formation of the voice, are the superior laryngeal, and the inferior laryngeal, or recurrent nerves. These proceed from the eighth pair, and are distributed to the intrinsic muscles of the larynx. The division of one of these nerves, enfeebles the voice, but the section of both, entails its complete extinction.

§ 6. *Production of the Voice and its Modifications.*

The proper organ in which the sonorous vibrations causing the voice are produced, is the larynx. The other organs are only accessory. The air inhaled into the lungs, when expired, is driven through the larynx; and this is the period when the voice is produced. At this time, if the vocal cords be rendered tense by the muscles of the glottis, and the expired air be propelled against them, vibrations are occasioned in it, producing sound, modulated at will, by the contractions of the intrinsic muscles of the larynx, especially those of the glottis. The opening of the glottis, or its two ligaments, the vocal cords, is the part of the larynx where the voice is actually formed. Their destruction, as Bichat

and Magendie have shown, causes obliteration of the voice, an effect that does not ensue from the destruction of other parts of this structure.

The larynx is a vocal instrument combining the principles of a wind, and a reed instrument: it differs, however, from all artificial instruments; to none of which it can be compared in an absolute manner. The vital contractions of the thyro-arytenoidean muscles, of which the vocal cords are aponeuroses, are essential to the formation of the voice, and, in this respect, no instrument can bear any analogy to the organ of the voice.

The voice, produced in the manner described, is susceptible of numerous modifications. In these consist the vocal expressions. Less numerous than the expressions of the physiognomy and gestures, their number is still very considerable, and they impart with energy and certainty the state of the wants, propensities, and internal sensations; or convey with clearness and precision the sentiments and thoughts. The expressive phenomena of the voice compose, therefore, two classes; the one representing the wants of the organization, the state of its being, the passions that agitate it: the other corresponding with the operations of the sentiments, and communicating the ideas originated in the intellect or understanding. The first order of phenomena are instinctive, and are attached to the condition of the organs: the second are arbitrary, or conventional, and are devised by human ingenuity.

a. Instinctive or Affective Vocal Expressions.

All animals possessing voice, are capable of communicating by it their wants and sensations. The acts for this purpose are instinctive, are independent of any positive volition, and are frequently executed in opposition to its mandates when attempts are made to suppress them: they are present in earliest infancy, and are not called into existence by education.

The instinctive vocal expressions are modifications of the voice, produced by contractions of the muscles of the larynx. Powerful sensations and emotions excite these muscles, convulsively, as it were, occasioning a variety of sounds, while those of a light character exercise no influence over them, and are not manifested in the voice.

This order of expressions consists of various and diversified phenomena. Every animal has its peculiar vocal sounds or cries, comprehended by its own species, and by those of nearly similar organization. They differ from each other by inappreciable tones, but are, notwithstanding, expressive of every variety of sensation and emotion. They announce pressing wants, they proclaim suffering, they declare apprehensions; they menace, they caution, they solicit, they implore, they repel: they express love and hatred; joy and sorrow; pleasure and pain; surprise and terror. In fine, the vocal instinctive expressions are as numerous as the sensations and sentiments to be expressed. Even the expression of the same kind of feeling corresponds with its different degrees. An experienced accoucheur is enabled by the cries of labour to determine the progress it has made, and the prospect of approaching delivery. Every variety of visceral suffering, when intensely severe, is attended with some peculiar vocal expression, indicative of its character. The study of these often throws light on the diagnosis, and assists the practitioner in forming the prognosis of disease.

The instinctive vocal expressions can scarcely be said to be, at any time, the subjects of disease. They are frequently symptoms, especially in disorders involving the nervous system. In hysterical paroxysms the muscles of the larynx are sometimes affected with spasms, and cause various vocal expressive sounds. Hydrophobia always offers, as a pathognomonic sign, excessive irritability and sensibility of the mucous membrane of the larynx, its muscles and nerves, so that an effort to swallow, or the contact of cold air will excite spasmodic contractions, and threaten suffocation. In the course of the disease, the contractions of the laryngeal muscles often cause vocal sounds simulating the cries and sounds uttered by animals.

b. *Arbitrary Vocal Expressions, or Speech.*

The capacity to form ideas, and create abstractions in the intellect, implies the power to communicate them to others. This is accomplished by language or conventional signs, which consist of gestures or the language of actions, and of speech. It is probable that all animals possess some kind of language, adapted to their

limited capacities, and restricted intellectual operations. Man alone enjoys this faculty in an eminent degree, and is the sole possessor of speech.

Speech differs from the instinctive vocal expressions in the organs of its formation, in the mode of its production, and the purposes it fulfils.

1st. The instinctive vocal expressions, it has been shown, are modifications of the voice produced in the larynx, and caused by contractions of the laryngeal muscles. Speech is the voice articulated. This last operation is accomplished in the vocal tube superior to the larynx, giving issue to the voice, and is effected by the moveable portions of the fauces, the tongue, and the lips.

2d. The vocal instinctive expressions are involuntary, and result from intense sensations, or strong emotions. Speech is always voluntary, and requires the action of an intellectual faculty, or organ. It has been conjectured that the faculty of speech depended on the formation of the human larynx. But this is not the cause bestowing that faculty on man. Speech, or articulated sound, is not produced, as has been shown, in the larynx, but by the movements of organs directed by volition. It is the possession of an especial intellectual organ to which man is indebted for this exclusive and elevated attribute. By the action of this organ, on those of the voluntary motions, muscular actions of the organs of speech are induced, producing arbitrary sounds, adopted as the representatives of special ideas. Were it possible for two human beings, who had never been taught a language, to be placed on an uninhabited island, they would soon invent a vocal language, becoming enriched with words, and extended in its significations, with the increase of the wants, and the multiplicity of the sensations. Animals are destitute of speech, because they have not been provided with an intellectual organ for artificial language.

3d. Each fulfils a different purpose. The vocal instinctive expressions are provided for the individual and social interests of the being. While they express his sentiments, and proclaim his wants and feelings, they excite a sympathetic emotion, or call faculties into operation, that may elicit the required actions. At the voice of suffering and distress, all who hear it, are impelled by internal feelings to afford succour and relief. Arbitrary or con-

ventional language, communicates ideas or intellectual operations, and is intended to advance the moral improvement of man, by extending the sphere of his knowledge, and thus imparting to him wisdom.

The production of speech is a complex operation, requiring the concurrent actions of different organs. The voice, produced as has been described, is essential for speech, and, consequently, likewise are its organs. Equally so are the motions of the vocal tube, extending from the rima glottidis to the mouth, modifying the voice, and with the tongue, lips, and cheeks, breaking the vocal sound; rendering it articulate, and giving it terminations, thus forming words. These motions are, however, voluntary, and are excited by nerves proceeding from the nervous organs of voluntary movements. But these could not of themselves form language; and must act under the influence and direction of an intellectual organ, recognising sounds as the representatives of ideas. Such is the mechanism producing speech.

Speech is frequently defective from some vice in the articulation. The formation and pronunciation of words, being artificial processes, are acquired with slowness and difficulty. Hence speech is liable to defects from mal-conformation of some parts of the vocal tube, from improper habits formed during its acquirement, or from a want of synchronism in the action of the organs requisite to its production.

The principal of these defects is stammering, or stuttering, (psellismus.) It consists in a difficulty of commencing articulate sounds, which are delayed a considerable time, and accomplished only after reiterated painful efforts, attended with a convulsive action of the muscles.

Many attempts have been made to give an explanation of the cause of this defect, and various modes to remedy it have been suggested. But as these theories were unfounded, the remedies proved of no utility. The true cause of stuttering has, I am disposed to believe, been detected by Dr. Henry M'Cormac, and announced in a treatise he has published on this subject.* In most cases the proximate cause, he asserts, "arises from the pa-

* A Treatise on the Cause and Cure of Hesitation of Speech or Stammering. By Henry M'Cormac, M. D.

tient endeavouring to utter words, or any other manifestation of the voice, when the air in the lungs is exhausted, and they are in a state of collapse, or nearly so." Another cause, that occasionally gives origin to this difficulty, is the attempt to pronounce words or letters in the act of inspiration, instead of expiration.

The theory of stammering having been determined, the means to rectify it are immediately suggested. This consists in reversing the mode of speaking in stuttering; that is, to take a full inspiration, and to expire the breath strongly whenever the attempt to speak is made. When the vicious habit has become very inveterate by time, it is not easily destroyed. It is, then, necessary to commence pronouncing in this manner the vowels; subsequently the consonants, and afterwards proceed to syllables, and finally to words. By perseverance in this system, the most confirmed stutterers can be cured of this most unpleasant infirmity, which sometimes nearly excludes them from society.

Lisping is a defect of much lighter character, and may always be removed by care in pronunciation.

§ 7. *Speech as Connected with a Pathological State.*

Speech is often affected in disease, and furnishes signs of great value to the practitioner in determining the seats and character of the affection.

Inflammation of the tongue, or the other parts employed in articulation, by destroying their mobility, causes impediments in the exercise of this faculty. The extreme aridness of the lining mucous membrane of the mouth, in the advanced stages of fevers, affects speech in a similar manner, rendering it inarticulate.

Ulcers in the larynx and trachea, congestions of the lungs, some cases of phthisis, &c. by injuring the voice, reduce speech to whispering, which is articulate sounds produced in the mouth without voice.

Affections of the nervous structure, implicating some one of the organs essential to speech, may injure this faculty, or entirely destroy it, producing mutism or dumbness. Lesion of the recurrent nerves, causing aphonia or loss of voice, will have this result. It will succeed to an injury of the nerves of voluntary mo-

tion, supplying the tongue, lips, &c. paralysing them, and preventing articulation; and lastly, it may be caused by a cerebral affection involving the organ of artificial language, and suspending its operation. The organs of the voluntary movements of the tongue, lips, &c. cannot, then, direct the specific motions necessary for the formation of articulate sounds or words. Mutism from this last cause may be known by the persistence of the voice, and the perfect mobility of the organs of articulation or pronunciation.

Dumbness is a symptom at times attending on cerebral diseases, and when it occurs in fevers is generally a fatal sign. In the American Journal of the Medical Sciences,* I have published a case of total loss of language, vocal and written, temporarily produced by cerebral congestion, and unattended with any other functional disorder. Speech was immediately restored by copious bleeding. This case is incapable of any other explanation, than that furnished by the doctrine of a specific intellectual organ for language. Two other cases have subsequently come to my knowledge. The one occurred in a girl attacked with fever, accompanied with violent cerebral symptoms. She was brought into the Alms-house Infirmary in the advanced period of the disease. The cerebral excitement was reduced by repeated local depletion, but she remains dumb, though in possession of all her faculties; she can comprehend every thing said to her, and is able to communicate her wants by signs. All the organs concerned in the mechanical process of voice and speech, preserve their integrity, yet she is incapable of forming words or any articulate sound. The other case is that of a gentleman residing a few miles from the city, and at present under the charge of Dr. Betton, of Germantown, and Dr. Moore, of this city. While engaged in superintending a merchant flour-mill, of which he is proprietor, he suddenly lost his speech, without suffering any other apparent affection, than the incapacity of expressing his ideas by articulate sounds, or even writing. The voice was unaffected, and the organs of vocal articulation enjoyed their perfect mobility. He has, after active depletion, recovered the power of speaking a few words.

Speech offers modifications, the consequences of disease. These

* Vol. 3, No. VI. for February, 1829, p. 272.

furnish important information in illustrating its diagnosis, and are useful as semiotic indications. The principal of these changes are, constant muttering, or speaking between the teeth; a rapidity or slowness of speech unnatural to the patient; taciturnity; obstinate silence; with stuttering, &c. The alterations of speech supervening in disease, are in general indicative of affections of the brain.

§ 8. *Of Vocal Musick or Musical Language.*

Singing is a mode of expression belonging to man, and to some animals. It is the voice modulated to sounds of melody and harmony. In singing, as in speaking, an intellectual faculty presides over, and determines the specific movements of the vocal organs, requisite for the production of the sounds and their combination, of which this act consists.

The talent for musick and singing does not depend immediately on the ear or the voice. They are only accessories necessary for its exercise. Hearing may be possessed of the most exquisite delicacy; the voice may be of inimitable sweetness; yet the individual may be perfectly incapable of understanding, or feeling the differences of musical tones, or the value of their combinations. Others who have an indifferent voice, are, however, often excellent singers; and those whose hearing is defective, may, notwithstanding, be accomplished musicians.

Time enters into the composition of musical sounds, and the possession of a faculty for its perception is a necessary integrant to a perfect musical talent. There are persons who have a delicate sense as to tones, but cannot understand time; while others, most admirable timists, cannot distinguish between a sharp and a flat.

Musick is, thus, seen to be a mode of expression founded in nature, and connected with our organization. It is not, as has been supposed, a mere invention for amusement, but the development of an instinctive and fundamental want of human nature. It is true, civilization and the advancement of knowledge have improved and refined its execution, and rendered it capable of rising above the coarse expression of the grosser senses, into the delineation of the more elevated conceptions of refined sentiments and intellectual thoughts. But it is not the less natural because

it is cultivated. The same results have attended language, and none will contend, because it has been improved, and received an artificial polish, by the exertions of genius, that language is, therefore, a mere device of talented men, and not founded in our social wants, and the constitution of our nature.

Musick being a mode of the faculty of expression, bears a relation to the sensations, to the sentiments or moral faculties, and, even, to those of the intellect, whose operations the expressions communicate and excite. Musick is not, consequently, of the same kind, but differs in its genius, in its style, in its composition, according to the faculties with which it is in relation. Those whose organization is endowed with an exalted sensibility, delight in, and cultivate music composed of the most melodious sounds, having a perfect accordance. Enjoying from these an exquisite pleasure, they seek not to awaken profounder emotions. This is the character of Italian musick: it belongs to, and emanates from, the sensations. It consists in the combination of the most delightful and pleasing sounds; it astonishes by brilliant and rapid passages, and the contrasts of tones, from the highest to the lowest notes of the musical scale: it calls into exercise, and delights in displaying all the powers of those flexible and melodious voices, so frequent in the delicate organs of its singers.

In other climates, where sensibility is more obtuse, musick is the language of the sentiments, of the passions, and even of the intellect. Its object is to hold a relation with the interior affections, to seize on the heart, to express its emotions, and to excite them into action; or to exhibit perfect imitations of exterior objects. It attempts then to impart by sounds the expression of thoughts, to paint the emotions and the passions, to imitate, and convey impressions of various things and effects in nature. Musick with them is a faculty of expression, and an art of imitation. It is addressed, not to the sensations, but to the moral being of man, and to attain its object, employs sounds of the greatest force and energy; while, to perfect its imitative powers, it employs combinations of strange, and, sometimes, discordant sounds. This is the musick of Germany, and was for a period that of France, subsequent to the memorable triumph of Gluck.* Since that pe-

* There is no English musick, except the ballad.

riod the musick of France has assumed a mixed character; it is less passionate and imitative, and combines more of melody and pleasing sounds in its composition.

The different species of musical style and composition, are different modes of expression; they are different dialects, and are addressed to different faculties. They are not, consequently, mere accidental variations; but are founded in nature, and connected with our organization. The dispute respecting their relative superiority and excellence is idle; each is appropriate, and has its peculiar merit.

The connexion of this mode of expression with the pathological state, is not of sufficient importance to engage, at this time, especial attention.

Musick, as a resource of therapeutics, and a means of hygiene, was not neglected by the ancient, particularly the Greek physicians. It possesses unquestionable powers in modifying the actions of the nervous system, and may be resorted to with decisive advantage. In a distressing case of epilepsy in the neighbourhood of this city, musick was the only means successful in arresting the paroxysms.

CHAPTER VIII.

Of Sleep and Dreams.

None of our organs are capable of sustaining unceasing action, without suffering in their functions, unless the heart be considered an exception; yet, in this organ, the periods of its repose are equal to those of its action. Intermittence of action is a law of the organization, indispensable to its healthy condition. This law is absolute in respect to the organs and functions of relation; it cannot be dispensed with, and is manifested in them by the most striking phenomena.

The repose of the functions of relation is sleep; and this state, so peremptory a condition of existence, nature has provided,

shall irresistibly be established, at certain intervals, that can be postponed but for a limited period. In sleep, the organs necessary to existence continue their functions, but those of the organs of relation are suspended, and all consciousness of the exterior world, and even individual existence, is lost.

The functions of relation cannot be exercised beyond a determinate period: they are exhausted by action. They would thus appear to depend upon a force produced in the nervous organs, wasted by their exercise, and experiencing a reparation in repose. To accomplish this is the object of sleep.

This absolute necessity of a suspension of action in the functions of relation, especially of the senses and psycological faculties, is a circumstance remarkable and singular. They are the most immaterial of our faculties, yet are the soonest enfeebled by exercise, and to which relaxation and absolute rest are of the most indispensable necessity.

The exhaustion, succeeding to the waking state, is indicated by internal sensations, constituting the *want of sleep*. These are, diminished energy of volition and attention, causing indisposition to motion, or mental operations; hebetude of the senses; then supervene gapings and pandiculations, followed by incapacity to keep the eyes open, to maintain the head erect, or support the body upright; and this, no longer sustained by the muscles, yields to the laws of gravitation, and compels the assumption of a recumbent, or sustained position.

In the invasion of sleep the senses first experience its inroads; the sight is dimmed, and the eyelids close; the taste, smell, and hearing, are suspended; and, lastly, touch ceases to be exercised. The internal senses, as hunger, thirst, and pain, are in like manner suppressed.

The intellectual and moral faculties suffer the same oppressive lassitude; their exercise becomes languid and painful; the ideas, dull and confused, are formed with difficulty, and without connexion; thought is at an end; a species of reverie, or rather, delirium, succeeds; and, finally, every act of the mind is suspended: perception and consciousness, the internal evidences of existence, cease; organic life alone is manifest; animal life, for a time, has terminated. The act of sleeping resembles, and is, in reality, a rehearsal of the act of dying.

A circumstance meriting notice is, that, at the moment, marking the complete supervention of unconsciousness, a sudden convulsive starting of the muscles occurs. In a state of perfect ease, this phenomenon passes unnoticed, but is manifested after severe fatigue, or when the joints, muscles, or aponeuroses, are painfully affected. The sudden start, by the pain it excites, then rouses the individual from his slumber, and banishes sleep from his eyes. I had a patient in a violent attack of gout, who was deprived of sleep many nights in succession from this cause.

In sleep, the muscles are abandoned to their own force, and, from the superiority of the flexors, the body and limbs are thrown into a demi-flexed position. In health, the body generally reposes on one side, and most frequently it is the right. By this position the inferior side of the thorax is prevented from expanding, and respiration is chiefly performed by one lung. The slower circulation of the blood, in sleep, admits of this diminished office of respiration. But in some affections of the lungs, (bronchitis, for instance,) or when the circulation is very rapid, both lungs are required for this process, and the patient is compelled to sleep on his back. Hence, sleeping on the side is a sign of favourable augury in disease, except in pneumonia affecting one lung, or effusion into one side of the thorax.

While, in sleep, the functions of relation are in profound repose, those of nutrition continue active. It has been asserted that they are performed with more energy and activity at this period. A state of antagonism was, consequently, supposed to prevail between the system of relation and the system of nutrition; that, the activity of the one, was the cause of the waking state, and that of the other, occasioned sleep; that, in waking, all the movements had an eccentrical tendency, and, in sleep, were impressed with a concentric determination.

It is not, however, certain that an increased activity does prevail in the nutritive functions.

The respiration becomes slower, though it is profound, approaching to the stertorous respiration of cerebral congestion and effusion.

The heart pulsates with diminished rapidity, and animal heat is less developed. The increased temperature, so frequent during sleep, is altogether produced by the bedding, and warm cover-

ing, provided, by all who possess the means, for that occasion, and which prevents the heat of the body from escaping. Besides, sleeping frequently occurs after the principal meal, and whilst the system is under its stimulating effects. It is a well known fact, that the impression of cold on the body is more profound, and less resisted during sleep, than in waking, under the same circumstances, which would not be, were calorification more active.

Digestion, it has been contended, is more active during sleep. Rest, in the first periods of this process, may, unquestionably, favour its performance; but profound sleep would appear rather to retard, than to advance it. Of those who eat heartily immediately before retiring to bed, the far greater number manifest unequivocal symptoms of impeded and imperfect digestion. They suffer from oppression at the stomach; they are subject to all the horrors of incubus; and are liable to attacks of a sense of suffocation. The tongue, in the morning, is furred, the mouth pasty, the taste depraved, and appetite is wanting.

The cutaneous transpiration is commonly augmented during sleep, but this effect results from the warmth in which the body is maintained. To this cause is to be attributed the aggravation of cutaneous affections when patients are in bed, and the predisposition to those diseases acquired by the indolent who indulge too long in the luxury of repose.

The secretion of urine is diminished during sleep, at the same time it contains a larger proportion of its saline principles, and is of deeper colour. Hence children who sleep much, and the indolent rich who lie long in bed, are subject to gravel and calculi.

Nutrition is more perfect during sleep, but is not more active than when awake. The losses of the economy are, also, diminished, and, from these causes, sleep gives a tendency to obesity.

The duration of sleep, or the time requisite for the reparation of the functions of relation, is from six to eight hours. Thus sleep occupies nearly a third of life; and he who has reached sixty years, as it respects the operations of the psycological faculties, including the time of infancy, has not lived more than twenty.

The duration of sleep is not uniformly the same with all men;

and it varies with the activity and fatigue of the waking state. Some individuals require a less period than others. Napoleon slept but little; and Caligula, it is said, but three hours. After exhaustion and fatigue, sleep is necessarily prolonged. Intellectual labours require a longer period for the reparation of the exhaustion they induce, than muscular fatigue.

Age exercises a considerable influence in this respect. Infancy demands a profound and prolonged sleep, while old age is wakeful. Females sleep more than men, and the feeble generally require a larger portion than the robust.

A full alimentation, and especially of animal food, causes somnolency, while fasting, vegetable diet, and coffee, promote vigilance.

No absolute rule can, then, be laid down for the proper duration of sleep. Of all the acts of our organs, none are as susceptible of modification, none may vary to as great a degree. Taking the most general medium, it will be found, that eight hours is about the natural period required for sleep. When too short a time is allotted for this purpose, the health of the system deteriorates, and premature exhaustion wastes the organs: if it be unnaturally indulged in, hebetude of the senses, and obtuseness of the intellect, are brought on.

Sleep presents great diversity in regard to its completeness. After active mental, and corporeal exertions, it is usually entire; as it is also in its first periods. But, it is rare, that all the senses and intellectual faculties have experienced the same exhaustion, and require a similar extent of reparation. Some, consequently, are less completely suspended than others, and are much sooner roused into activity; they either remain sensible to the impression of external excitants, or very soon reacquire a susceptibility to respond to them. Sleep will, then, be less complete; and especially towards the period of awakening; at that time, as previous to complete sleep, a species of light delirium, from the unconnected ideas floating in the mind, is observed to exist.

Sleep, in its profoundness, varies from a light dose, a mere stupefaction of the senses, to a comatose condition without a trace of consciousness, or thought. Some sleep so lightly, their senses are so little steeped in oblivion, they are roused by the slightest im-

pressions on their senses: others can scarcely be awakened by the loudest noises, and most violent agitation. A gentleman, formerly of this city, now deceased, noted as a lethargic sleeper, was supercargo on board an Indiaman, wrecked in the Delaware Bay in a violent gale, during which he slept undisturbed by the confusion and danger of the scene.

Perception, in sleep, is often present without consciousness; that is, impressions on the senses are perceived, and corresponding acts performed, without specific volition, or the act of an intellectual or moral faculty. Irksome postures of the body are changed; when a limb is irritated it is withdrawn; and yet the mind is not conscious of these impressions, nor determines the movements. The same automatic acts occur in coma, apoplexy, &c. and depend alone on sensibility.

The immediate cause of sleep is a problem difficult to resolve. Its object, doubtless is, to place the brain and nervous system in a condition for the exercise of their functions; to restore to them the susceptibility to receive exterior impressions, and to perform internal acts, lost by their continued operation, and during the waking state. But, in what does this condition and this susceptibility consist? They are unknown. We have no means to determine their nature with certitude.

Do they consist in the loss of a principle formed in the nervous structure, and exhausted by action, or do they depend on a modification of that structure, resulting from its activity, and ceasing from repose? In the determination of these questions, it must be confessed, we have little more than conjectures as our guides.

In examining the phenomena attending sleep, many symptoms are to be detected, assimilating it to the torpor resulting from sanguine congestion of the brain. Whatever causes sanguine congestion of a moderate degree, produces somnolency, the intensity of which is proportioned to the extent of the congestion. All the narcotics, stimulating the brain in the first instance, and increasing its activity, terminate in the production of a congested condition, and occasion sleep. Alcoholic liquors have a similar mode of action, and result in effects nearly the same in their character. In like manner, mechanical, or other compression of the brain, suspends intelligence, and produces a lethargic somnolency.

In all the preceding instances, a state having the strongest ana-

logy to sleep, ensues from an excitement of the cerebral nervous structure, determining towards it an afflux of blood, and, thus, forming sanguine congestion.

During the waking state, the functions of relation are unceasingly excited, and are in a state of activity. But the functional actions of an organ are excitative of its nutritive actions, and directs to it an afflux of sanguine fluid, (Prop. 2d.*) This process occurs with the cerebral organs from their active operations, and the tendency to a congested state diminishes their powers, and induces sleep. When the waking state is extended considerably beyond its natural period, and the excitement of the brain is continued, the face becomes turgid and flushed, the eyes are injected, the head is heated, and a sentiment of fullness is experienced. Here are exhibited striking evidences of the sanguine afflux and turgescence established on the brain. If sleep be forcibly prevented, these symptoms augment, a true pathological state ensues, eventuating in death. The Romans, with a barbarous refinement in cruelty, doomed Perseus to this terrible death.

The accumulation of blood in the brain always induces somnolency, and the invasion of sleep is, evidently, attended with an afflux of sanguine fluid within the cranium. Still it cannot be affirmed positively, that this is the proximate cause of sleep. It may merely be an accompaniment of that state. The question must remain involved in obscurity, so long as we are entirely ignorant of what constitutes the active state of the nervous system, and the power by which it executes its various functions. At present we can merely assert, that two states prevail in the nervous system; the one, its activity, or the waking state, when it executes the functions of relation, and which can continue only for a limited period; the other, its passive state, or sleep, in which is restored the power to resume its functions. The nature of these states, and the mode of action of each, are too recondite to be penetrated with our present means of research; and our knowledge is mere glances along the surface. We know only as certain, that these states irresistibly succeed each other at limited intervals; and that the one is reparative of the condition induced by the other.

* Page 230.

In addition to the above causes of sleep, it succeeds to a direct diminution of the action of the brain, from the abstraction of its natural excitants, as light, sound, odours, &c. and whatever produces impressions or sensations. Without the action of these, the cerebral organs are not called into activity, and sleep is more frequent and prolonged.

§ 1. *Of Sleep in its Pathological Relations.*

Unusual somnolency, and sleep unnaturally profound, are attendants on disease; though a morbid vigilance, or sleeplessness, is a more frequent symptom.

Somnolency is an intermediate state between sleeping and waking; imperfect consciousness continues, but the faculties are sluggish, and attention is dull. It is commonly an effect of a plethoric state, and fullness of the cerebral circulation.

When sleep is very heavy, and the patient can with difficulty be roused, *stupor* or *coma* prevails: it is a more aggravated form of the preceding state, and marks a stronger afflux towards the brain, and a deeper congestion of its vessels. It is sometimes attended with light delirium and talking, when it is termed *coma vigil:* but when the patient speaks only while roused, it is called *coma somnolentum.*

More aggravated conditions are characterized as *lethargy* and *carus.* In lethargy it is yet possible to awaken the patient, but he immediately relapses into an unconscious state: in the carotic condition he can no longer be awakened.

These different degrees of the same state constantly arise from cerebral congestion, and, in the worst forms, more or less of sanguine or serous effusion prevails at the same time. They are not diseases in themselves, but are symptoms, and depend on sanguine irritation in the brain or its meninges, giving rise to the congestion or effusion, their more immediate cause.

Insomnia, or morbid vigilance, is a more constant result of disease, than its opposite state, just considered. It is most generally a sign of cerebral excitation: and whatever activates the circulation and functions of the brain, as coffee, strong green tea, the first operation of the salts of morphia, the commencement of fevers, excesses of sexual intercourse, &c. occasion morbid vigi-

lance. It is, also, an attendant on the convalescence of severe and dangerous diseases.

Mental alienation is frequently preceded by obstinate sleeplessness, which accompanies its first periods. It is due to the irritation of the cerebral structure, or the meninges, the most common proximate cause of the affection. In all acute diseases sleeplessness is a presage of imminent delirium, and threatens danger. It is a characteristic symptom of mania temulens.

Sleeplessness, while it is a symptom most distressing to the patient, is often most difficult to relieve. Bleeding in acute fevers is frequently of no avail; neither does opium nor narcotics succeed; and are besides counter-indicated by the disease. Titillation, gentle frictions with soft substances, warm pediluvia, warm lotions, and the warm bath, may be resorted to; and the arts of the animal magnetizers, which, in nervous temperaments, often diffuse a calm and luxurious tranquillity in the system, and thus dispose to sleep, it might be proper, on some occasions, to put into operation.

§ 2. *Of Dreams.*

Sleep is seldom complete or perfect, especially towards the period of waking. Complete suspension of all the psycological operations does not exist; some continue in activity, or awake; ideas are formed, and consciousness is not entirely absent. From this state of imperfect sleep, and partial repose of the intellectual and moral faculties, proceed dreams. A single organ of the brain, or mental faculty, being in an active state, ideas must of necessity be present; but they will, then, be unconnected and without order, whence the dreams are strangely incoherent. When, however, groups of organs habitually acting in concert, are in this state, then, the ideas possess more arrangement, and the mental operations more method: dreams acquire a certain degree of rationality; and even completely regular intellectual operations, as the composition of poetry, or the solution of some theorem, are performed with all the intelligence and acuteness of the waking state.

In the first periods of sleep, when persons are in the enjoyment of health, and moderately exercise their intellectual faculties,

dreams seldom occur; and when they do, generally proceed from some uncomfortable internal or external sensations, exciting a portion of the cerebral structure. As all the faculties are not equally exercised, those whose organs have not been exhausted speedily recover their force, and, either spontaneously enter into action, or are easily roused by exterior excitants. As the hour of waking approaches, a greater number of the organs assume the same state, the recuperation of the senses advances, and their sensibility to impressions becomes constantly more acute. Hence it is, that the dreams at this period, it is a common observation, have a strong resemblance to actual occurrences; which has led to the vulgar remark, that morning dreams are true.

In some few instances, during sleep, a number of faculties assume an activity commensurate with the waking state; the thoughts are connected and combined; the intellectual operations possess a complete rationality; and voluntary acts are commanded and executed. This state constitutes *somnambulism:* it presents numerous gradations, and, when in a high degree, differs from the waking state only in consciousness. The somnambulist will enjoy the full exercise of all his faculties, converse, walk, perform various operations, sing, compose verses, &c. yet, in the waking state, have no consciousness of what has occurred. In this respect somnambulism differs essentially from dreaming, and approaches to a morbid state: in a high degree it cannot be considered other than a disease, and as having a strong analogy to epilepsy.

Very remarkable, and even wonderful accounts of somnambulists have been published, but, in some of these, it is to be suspected, credulity existed on one side, and imposition was practised on the other. Extreme circumspection should be exercised in all these instances to avoid the acts of deception and fraud, for which the pretext of somnambulism may be a cover.

Somnambulism, or a nearly similar state, is artificially brought on, in persons of acute sensibility and highly excitable nervous temperament, combined with strong imagination, by the practices of magnetizers. It differs from that spontaneously produced, as those affected in this way do not move about, and perform voluntary actions. Its phenomena are confined chiefly to conversations; and to pythonick responses to the questions of the opera-

tor, managed with all the acuteness, skill, and dexterity of an aruspex.

The general tenor of ideas in dreaming is the same as that with which the mind is occupied awake; and thus may be revealed, in dreams, the state of the mind, the secret hopes and wishes, the profoundly hidden thought, and often the circumstances of the dreamer. The knowledge of this fact, and its dextrous application, by an acute observer, with the credulous, compose the art of oneiromancy.

Those who occupy the mind with laborious studies, and are engaged in investigations requiring deep thought seldom dream. The exhaustion of their faculties renders longer, and more profound repose necessary; and their sleep is rarely interrupted with dreams: the idle and indolent, whose mental faculties are but slightly exercised, on the contrary, seldom sleep without dreaming.

Impressions excited in dreams possess at times so much of vividness and force as to be confounded with waking ideas, or those derived from actual impressions on the senses. They are, then, supposed to be the result of realities, and it is difficult to produce a contrary conviction. This is the origin of many stories of visions, and supernatural revelations.

§ 3. *Of Dreams as connected with a Pathological State.*

From the theory of dreams, it is evident, that whatever causes unusual impressions, or disturbances of the actions of the system, and, thereby, interrupts the perfect repose of the intellectual and moral organs, will give rise to dreams. But the ideas of dreams, when excited by impressions, always partake of the character of those impressions, and should they be of an unpleasant and painful nature, the dreams will be distressing.

Deviations of the actions of the cerebral organs, from their natural order, whether primitive or secondary, are attended with corresponding affections of the intellectual operations. To the phenomena thus induced dreaming belongs; and consequently furnishes signs indicative of the actual state of the cerebral structure. There is, then, a medical oneiromancy, founded in positive

facts and observations, free from juggling, or deceptious practices, and which will often present to the practitioner important information in determining the modifications in the state of the brain, and their relation to the healthy state. Dreams are then connected with the healthy or morbid condition of our organs, they belong to pathology as well as physiology, and are of no mean value as diagnostic and prognostic signs.

There are two classes of dreams; the one attached to the natural action of the brain; the other depending on its pathological condition.

The first are dreams occurring in the manner already described, and the effect of the natural activity of the intellectual faculties. They usually occur towards morning, the period when the faculties enter into the waking state, and the ideas on which they are employed, are those that habitually occupy the mind, or are of the same character.

Dreams excited by active external impressions, or sensations, as from temperature, the contact of foreign substances, sounds, and uncomfortable positions, &c. calling prematurely the intellectual faculties into action before the completion of their repose, belong also to this class.

Prolonged excitement of the mind, in intellectual labours, by producing an irritation of the brain, will cause frequent dreaming, often of a distressing intensity, preventing the refreshment of sleep. This variety of dreaming is within the range of health, but denotes predisposition to disease, and indicates the propriety of discontinuing for a time the occupation whence it proceeds.

Pathological dreams are excited by irritations developed in the cerebral organs, maintaining the activity of a portion of them, and preventing their repose. The cerebral irritation is generally secondary, emanating from disordered actions of the stomach, of the organs of the circulation, of respiration, and generation.

The affections of these organs, especially of the two first, exercise a constant influence over the brain, modifying its actions; and hence they invariably procure disturbed sleep.

The internal sensations produced by the morbid condition of the organs, differ from those of the natural state. Being usually oppressive and painful, the ideas awakened are not of the common order, and the dreams are composed of trains of thought and

ideas entirely different from those generally occupying the intellect.

To dream immediately on the commencement of sleep, is always a sign of disease, as it is out of the order of nature; and dreams, painful and distressing in their tendency, are always the consequence of disturbance or disorder in some of the functions of the economy. Dreams of this character indicate, therefore, either the approach of disease, or its actual presence.

Dreams filled with scenes of terror and distress, with fancied sufferings, menacing dangers, in fevers, or other diseases, are of unfavourable augury, and announce a protracted and dangerous affection. Those in which the ideas are gay and pleasant, which present to the mind agreeable illusions, are, on the contrary, a favourable sign: they presage a mild form of disease, convalescence, and recovery.

The forming state of most, and, particularly, of continued fevers, is attended with an imperfect sleep disturbed by dreams. The same circumstance is a frequent precursor to mental alienation: instances have occurred in which the subject of a dream, preceding the disease, has been that of the subsequent delirium. It is rare, in fact, that impressions and sensations of any force, or disturbances of any function, and which are the usual attendants on the approach of disease, do not excite dreams, having often reference to the seat, or the subject of the unusual feelings, or the suffering induced. Thus, local inflammations have been preceded by dreams, of which some circumstances respecting the subsequent seat of the disease, were the subject.

Gastric diseases, almost without exception, excite dreams of an unpleasant character, in which the individual fancies himself to be placed in situations of great peril, threatened with some horrid death, or terrified with spectral forms, and monsters of horrid aspect—"gorgons and hydras dire."

Chronic inflammation of the pericardium, and of the heart, and organic disorder of this organ, prohibit sound sleep, and cause dreams of great horror. The patient is denied the refreshment and invigoration of repose. He is incessantly oppressed with terrific ideas of death by suffocation in some form, and starts erect, or leaps from the bed in agony and alarm.

Oppression of the digestive, circulatory, and respiratory or-

gans, with disorder of their functions, is the principal, if not sole cause of *incubus* or *nightmare.* In this affection the patient experiences a sense of weight and suffocation from some object seated on his chest, the forms of which are fashioned by the character of the intellect, and of the intelligence of the individual. A circumstance frequently observed in this state, is a temporary impotence of volition. The strongest desire is experienced to move the body, or a member, and the will is strenuously, but ineffectually exerted for this purpose. This difficulty sometimes continues a short time after a return of consciousness. This state is the reverse of somnambulism, in which the muscles obey without difficulty the influences of volition.

More ample details on this subject would be here inapposite. Sufficient has been shown to establish the necessary connexion existing between dreams, and the actual condition of the organs and functions of the economy; and no doubt can be entertained as to the utility to be derived from studying them, in reference to the diagnosis and prognosis of disease.

PART II.

Organic Functions, or Functions of Nutrition; and the Functions of Reproduction.

General Principles.

Organized beings proceeding from a germ, are developed after a type special to each genus, by the addition of constituent elements derived exteriorly. This constitutes their growth.

The actions of organized beings are, moreover, attended with a waste, or alteration of their elements, disqualifying their structure for the offices of vitality; and hence is necessitated a renewal of the materials of their composition. This is accomplished by nutrition.

The extrinsic matter, before it can be adapted for the purposes of growth and nutrition, requires an elaboration, completed by various processes; it is, then, distributed through various channels, and in different proportions to every part of the structure; and is, finally, deposited in the interstices of the pre-existing molecules, part of which are removed, or disappear. Nutrition is, consequently, a molecular action, comprising a composition and decomposition incessantly carried on in the intimate structure of organized beings.

The series of processes effectuating the above purposes, compose *the functions of nutrition, or the organic functions.* They are digestion, absorption, respiration, circulation, nutrition or assimilation, secretion; and as an attendant circumstance, or consecutive effect, calorification.

By the exercise of these functions, the individual organization arrives at its perfect completion, and its existence is maintained. But, for the perpetuation of the race, and continuance of the species, a germ is unfolded, endowed with specific organic dispositions. These remain, however, quiescent, unless a susceptibility

to enter into action, under the influence of appropriate stimuli, be imparted by the act of fecundation, the object of that process, when its separate or individual existence commences, and it acquires a birth at determinate periods, and after a certain mode. The various processes adapted to these purposes, form the *functions of generation or reproduction.*

These orders of functions are not dependent on those of relation; for, in many animals, and in plants, the last have no existence. They are of course independent of volition, which exercises no control over their actions. Still they are not isolated and withdrawn from the influence of the nervous system, at least in the higher classes of animals. A particular arrangement of nerves, or department of the nervous system, is consigned to the use of the organs executing those functions; and, in the degeneration of structure, attending the descent of the animal scale, it persists after the nervous system of relation has disappeared. This department is the great sympathetic or ganglionic system of nerves. The structure of this system having already been detailed, and its functions been the subject of investigation,* a repetition of them here is unnecessary.

I would, however, remark, that a question of interest and of considerable importance arises, that yet awaits a decision. Is nervous power an indispensable requisite to the performance of the nutritive functions, or, is it merely an accessory? The affirmative determination would imply, that growth, and the nutritive processes, can never be executed without a provision of a nervous system of some kind. But what evidence have we of a nervous structure in the amorphous animals, and in vegetables? None has yet been detected; and until its existence is demonstrated, the negative decision may fairly be maintained. M. Dutrochet, it is true, has attempted to establish the presence of the elements of a nervous structure diffused throughout plants, in what he calls nervous corpuscles, and producing irritability, or, as he terms it, nervimotility. But he founds his opinion on facts deficient in conclusiveness. These corpuscles, naturally diaphanous, are rendered opaque by acids, and their diaphaneity is restored by alkalies. The same circumstances take place with the globules of the

* See page 35.

brain and nerves; and hence, he infers the two must be identical, and, consequently, plants are possessed of the rudiments of a nervous system, though not collected and arranged into masses or organs.

It may be objected to this conclusion, 1st, that chemical tests for microscopical objects, must be too uncertain to justify a positive reliance on the phenomena observed. Before we can be authorized to found inferences on these phenomena, they must be confirmed by different authorities. One alone, however eminent for accuracy and acuteness of observation, is not sufficient to furnish a guarantee against error; and a diversity of testimony to the correctness of points involved in so much obscurity, must be demanded before they can be made the base of a sweeping doctrine. 2d. The phenomena themselves, standing alone, do not sanction any other conclusion, than a general analogy between the two substances; they are not proof of an absolute identity.

M. Dutrochet appears to have laboured under the preconceived notion, that irritability must be a property of nervous tissue, and its presence is a necessary implication of a nervous structure, and, therefore, he was disposed to find this structure in plants, the irritability of which is so fully recognised. This is begging the question. So far as the functions of the nervous system have been ascertained, and this is not inconsiderable, the capacity of responding to the impressions of stimulating agents, possessed by all organized matter, is not derived from this system, but is acquired in the formative process of nutrition. It is a first result of organization, precedes the appearance of nervous structure, is manifest in a high degree where no trace of nervous matter can be detected, and, instead of being a functional property of the nervous system, is necessary to its production, and the maintenance of its actions and functions. To contend that irritability is a functional result of nervous structure, while it is, at the same time, immediately necessary to the production of this function, involves an absurdity. It is making a thing the cause of itself.

The same process of reasoning is applicable to the nutritive function. Nervous structure is a product of nutrition, formed of the animal elements, derived from external matter. The commencement of this function, in the germ, must, then, be antecedent to the existence of nerve. Nervous structure and power

cannot, therefore, be regarded as indispensable requisites for the performance of the nutritive functions.

Though nervous power may not be an indispensable accompaniment of the nutritive actions, yet, it may influence the mode of their performance in a positive manner, by its excitative or modifying activity, precisely as they are influenced by other stimulating agents, as caloric, light, electricity, air, &c. Another office, and a most important one, of the nervous system of the nutritive organs, is to impart a concurrency to their operations, combining them into a unity, or forming of them a single system, harmonizing in the very diversified parts its different organs fulfil. At the same time, this system is associated with that of the functions of relation; it is united with the encephalon, where is situated consciousness and the perceptive faculties. By this arrangement, the numerous organs, composing the economy of the higher order of animals, are made dependent on each other, and all are subjected to a common centre of vital actions; the wants of the organism, and the deviations from a natural state, to which every organ is liable, from the agency of numerous causes, are made known, and the intelligence, warned of their condition, is excited to the provision of adequate and appropriate means to supply or remedy them.

Without this association of the organs through the medium of the nervous system, the play of the complicated mechanism of the animal economy, deficient in a common power of action, could not be maintained in regularity, and would be exposed constantly to fatal derangements.

A correspondence between the organs is an obligatory provision, for preserving the concurrency of their actions, and the equipoise of their powers. Independence of their actions is incompatible with the mutual subserviency of their functions. A single organ, in that case, being disordered in its actions, if all those operating in the same circle, were not similarly affected, but were to continue acting with the energy of health, the diseased organ would inevitably be destroyed, by the labour continued to be thrown on it in its disabled condition, and the call incessantly made on its coadjuvant office, while incapacitated in its functions. Thus circumstanced, a restoration to the healthy state, for which the suspension of function, as far as practicable, is a

40

first and indispensable condition, could never be accomplished. But, by the provision of a sympathetic association, established through the medium of the nervous system, the functions of all the organs, belonging to the same order, are brought to the same level, and an entire or comparative state of rest is, thus, induced, presenting the opportunity for the operation of recuperative processes.

Hepatitis, or inflammation of the liver, will furnish an example illustrating the principle. This organ forms a portion of the digestive apparatus, and its functions are an indispensable part of the process of digestion. When actively diseased the stomach sympathizes with it; the appetite is lost; and its digestive function is impaired. The liver, consequently, is not called on for the performance of its office, and it ceases to experience the excitation requisite for functional operations. The intermission of function is, of itself, frequently sufficient for the recuperation of diseased organs, and is of absolute necessity for their return to a healthy state. Now, if this sympathetic connexion did not exist, and the stomach continued to preserve undiminished its functions, the appetite demanding food, and digestion being vigorous, the functional acts of the liver would be required, and, consequently, excited into action. Inflammation once established in it, would be constantly augmented, and its destruction a result that would almost inevitably ensue. Inflammation of the kidneys, whose function is depurative, presents another instance to the same purpose.

The intimate association of the organs of the same order, producing a commonness of being and actions, is thus evidently a necessary condition for the safety of the organism, and the restoration of the organs to a natural state, when they have once departed from it. Other objects are attained by this connexion, and will be pointed out when treating of the sympathies.

The connexion of the nutritive organs with each other, and with the common centre in the encephalon, which has been shown to be essential in the animal mechanism, is established by the sympathetic nerve or ganglionic system. That it executes any other office is certainly not demonstrated. Its immediate and necessary agency in the functional actions of the organs of nutrition, will not be formally denied, as it is an opinion sus-

tained by numerous authorities; yet, I must confess, the evidence in support of it, is by no means satisfactory; many facts are in opposition to the doctrine; and it does not appear to be a circumstance necessary to their performance.

CHAPTER I.

Of Digestion.

The reparative materials, on which the functions of nutrition are exercised, are derived exterior to organized beings. In vegetables and animals of the simplest structure, these materials are elaborated previous to their introduction into the beings they are destined to sustain. They require only to be absorbed to undergo the process of assimilation, and be converted into animated matter.

In man and animals of a more complicate structure, the elaboration preparing the reparative materials for their introduction into the organism, and their employment in nutrition, is accomplished by organs within the being, provided for that purpose. This process constitutes digestion, and the organs executing it, compose the apparatus of digestion.

All exterior matter is not adapted to become nutritive, and of that consumed by animals, a portion only really possesses this attribute. The materials employed for this object are named aliment and nourishment when solid, and drinks when fluid. They are derived from the vegetable and animal kingdoms exclusively, with the exception of water.

The separation of the nutritive and assimilable, from the innutritive and unassimilable matters, and the preparation of the first in order to be absorbed into the organism, are the ends of the process of digestion.

In vegetables and the simpler animals, these effects are produced exterior to, and independent of their organs; and entirely

unconnected with any vital action. They are, consequently, a purely physical result, proceeding from chemical actions, over which they possess no control. Digestion is a function that does not properly belong to them.

In the higher animals the concurrence of organs and vital actions is superadded, and is essential to the completion of the process. Notwithstanding, in its character it is essentially a chemical process; but, the more compounded nature of the aliment, and its appropriation to a more exalted species of organization, necessitates a complicated apparatus, and means of greater energy, acting in a regular order, for the reduction of the aliment to the nutritive elements, and capable of being put into operation, whenever required by the wants of the economy. The immediate dependance in which the existence of the being is held on the regularity of its exterior supply, and the quality of the exterior matter it receives, is also an obligatory reason, that the supply of exterior matter, and the process of adapting it for the purposes of nutrition, should be placed at the command of the animal, and be subjected to its direction. A dependancy in these respects, on external casualties, would have been to have jeoparded incessantly the existence of the individual.

Digestion in man is an exceedingly complex process. To comprehend it in its natural state, or its connexion with a pathological condition, the various circumstances attached to its performance, and the organs belonging to this function, with their respective offices, require a general exposition: and of these the first inviting attention is the nature of aliment or food.

Sect. I.—*Of Aliment or Food.*

By aliment or food is to be understood those substances susceptible of undergoing a change in the digestive organs, and furnishing principles, that, absorbed into the interior, sustain the actions of the economy, renew its structure, form the materials of its growth or development, and repair its losses. Whatever resists the action of the digestive organs, and retains its characteristic properties, cannot be an aliment; and when those properties possess the power of disturbing, or modifying the actions or tissues

of the organs, the substance is a medicine or poison, according to the degree of its activity, and the intensity of action it provokes.

Some medicinal substances occasionally yield to the powers of the digestive apparatus when endowed with exalted energy. They then lose their medicinal character, become alimentary, and cease to exercise the wonted influence over the organs. Alimentary substances, also, frequently oppose the digestive actions when feeble. They may, then, produce disturbances in the digestive apparatus as violent as those induced by medicines; and, when the irritability of the stomach and bowels is acute, but little inferior to those resulting from poisons.

Organic substances alone can constitute aliments; hence they are entirely derived from animals and vegetables. Mineral substances are totally unfit for this object. Even the disorganization from putrefaction destroys the nutritive character of alimentary matters.

Aliments do not consist entirely of nutritive principles, but contain accessory materials confounded with them, and requiring to be separated; this is accomplished by digestion. The nutritive principles are few in number; but the others are numerous, and give the infinite variety existing in alimentary substances. The accidental united to the nutritive principles, often possess, especially in vegetables, medicinal, and, even, poisonous properties: from this cause, alimentary substances, while they nourish, may be made to modify the condition of the tissues.

Hippocrates advanced, as an opinion, that, notwithstanding the great diversity of aliments, there properly existed but a single nutriment. It was generally adopted, and in modern times precision was imparted to it, by assuming, that mucilage was the nutritive principle.

The organic elements constituting the animal structure, are dissimilar in their nature; and the different tissues, forming the solids, are composed of different elements, and are not constructed of the same substance.* But the elements of the animal structure are derived from the aliments, and it is not to be presumed, that a single nutritive principle can be the sole origin of all the

* See page 12.

organic elements, and the only source of all the diversities of the tissues entering into the composition of the organs of the economy.

If an examination be instituted of the composition of alimentary substances, as compared with that of the animal organism, it is immediately apparent, that those of an animal nature contain the same elements as the solids and tissues of our economy. Vegetable aliments, though not presenting the exact proximate organic elements existing in the animal structure, contain, notwithstanding, principles having the strongest analogy to them, and which, by slight modifications in the arrangement of their integrant elements, it can readily be perceived, could assume all the peculiarities characteristic of the animal materials. This modification, it is a part of the digestive functions to execute, converting the elements of vegetable into those of animal substances. Digestion in herbivorous animals, or those whose sole nutriment is vegetable, is a more complicated process, than in carnivorous animals, and requires a more complex and numerous apparatus. This proceeds from the greater change vegetable principles must undergo before they are converted into animal principles.

Animal and vegetable substances differ in their chemical elements. The first contains azote, of which vegetables generally are deficient, and when it does exist, it is in smaller proportion, than in animal matter. The last contain carbon in much larger proportion, than animal substances. In the process of digestion, changes are accomplished in the proportions of the chemical elements of the aliment, adapting them to the organization they are destined to nourish, and when azote is deficient, it is acquired in this operation.

The last anatomical analysis of the animal solids, resolves the organic tissues into two forms; globules, and an amorphous coagulable substance.* Alimentary substances, macerated in saliva after mastication, I have ascertained by repeated observations with the microscope, are also resolvable into the same elements. Fibrinous meats, vegetable fecula, and sugar; that is, the most nutritious aliments, contain the largest proportion of globules, resembling, as far as appearances observed by the microscope can be depended on, very closely the globules of the animal solids, and of the blood.

* See page 16.

These globules disappear when putrefaction is established. From the experiments and observations I have made, I am disposed to infer, that the nutritive and digestible qualities of food, depend on the presence of globules and coagulable substance in our alimentary matters, similar to those of which our tissues are formed, and the facility with which they can be resolved into a free or disintegrated state.

Aliment is not the same for all animals. Some can subsist only on vegetable food, and their digestive apparatus is incapable of bringing animal food into the nutritive elements. Others can live only on animal food, and their digestive organs are equally impotent in their power over vegetable matter. Others, and to which man belongs, digest, and are sustained equally well on both species of food.

The flesh of animals that live on vegetable food, is very digestible, and highly nutritive; but that of carnivorous animals is indigestible, and incapable of serving the purpose of nutrition. Though no very apparent difference is to be observed between them, this circumstance is an evidence of considerable dissimilarity.

Animal food, though more easily digested than vegetable, is more stimulant to the stomach, and more productive of heat and general excitement. In all cases of imperfect digestion, resulting from gastric irritation, the most common cause of dyspepsia, the general recommendation of animal in preference to vegetable food, is exceedingly erroneous, and founded on most incorrect views. In consumption, and in all chronic diseases depending on local inflammations, and which are excitative of febrile symptoms, animal food is injurious, and should be interdicted.

Food of the same nature, that is, animal or vegetable, differs materially in its digestible qualities, and its effects over the actions and nutrition of the economy. Each species possesses something peculiar in its qualities, and has a speciality in its effects.

Fibrin is more nutritive and exciting, than gelatin or albumen; it requires also more powers, and a longer period to digest, than they do. Its digestion is always attended with heat; it is, then, incompatible with all diseases of sanguine irritation, and should be sparingly used by those liable to such affections. The flesh of old animals abounds in fibrin and in osmazome, that principle

highly stimulating in its effects, and forming the reddish-brown, sapid, and aromatic crust on roast beef, mutton, or veal.

Gelatin has little or no exciting properties, and requires commonly some stimulants to be associated with it, that it may be digested. It is not of easy digestion, passes rapidly through the alimentary canal, and in this way often proves laxative. It never excites heat or stimulates the functions. Gelatin abounds in the flesh of young animals. Meats of this character are adapted to the sanguine temperament; to those disposed to gastric irritation; and should be preferred in warm climates and seasons.

Albuminous food when very slightly cooked or diluted with water, digests with great facility, is very nutritive, and does not disorder the functions, or develope heat in the stomach. Too much heat in its preparation, by increasing the cohesion of its particles, renders it indigestible. The food in which albumen predominates is, oysters, muscles, eggs, brain, liver, sweet-bread, or the pancreas, and blood.

In fish, these principles are combined in nearly equal proportions; and they are entirely devoid of osmazome.

Vegetable substances and principles, offer diversities equally great in their qualities, the effects they produce, and the modifications they exercise over the actions and nutrition of our organs. This is not the place to enter into details on this subject, but every practitioner should be familiarly acquainted with the peculiarities of each, that he may be enabled to lay down instructions to his patients, as to their regimen, drawn from positive principles.

Animal food when raw, cannot be digested; it always requires to be cooked. The same rule applies to most vegetables, except ripe fruits, which are, however, brought to a state analogous to that produced by cooking; and some oily nuts. Both are however improved and rendered more digestible by cooking.

The preparation of food influences its qualities, and the actions it excites in the economy. The art of cookery, though unattended to by physicians, is almost as much a branch of medicine as pharmacy; and nearly as important in the management of diseases. The object of cookery should be to render food digestible, to diminish the labour of the stomach, to present the nutritive principles as much divested as possible of extraneous matter;

to destroy its injurious properties, and to adapt it, in the preparation of dishes, to the powers of the digestive organs, the individual temperament, the predisposition to disease, or disease actually existing. The prolongation of life, and enjoyment of health, are more immediately dependant on good cookery, than on medicine. Health cannot long be maintained, where there is a bad kitchen. The perversion of cookery converts the art to a flattery of the palate, instead of an assistant of the stomach, and by leading to excessive repletion generates gout, rheumatisms, and disposes to apoplexy, and other affections.

Animal aliment is more thoroughly digested than vegetable, leaves less residue, and remains a much longer period in the digestive apparatus. Its residue, or fecal matters, is besides more irritating.

The more of nutritive matter contained in aliment, whether animal or vegetable, the longer it remains in the alimentary canal, and the more it exercises the digestive organs. Innutritious food, or that poorly provided with nutritive juices, passes rapidly through the digestive tube. The same is true of food that resists the digestive process. It excites the muscular tunic of the stomach and bowels, and is soon expelled from them. Hence they may be employed as laxatives, to keep the bowels free, and are to be preferred for that object, to purgative medicines; such are oils, saccharine and acidulous fruits, manna, &c.

Aliment furnishing the materials of the animal solids, and differing so very greatly in its nature, in its properties, and in its effects over the actions of the economy, offers to the practitioner the most effective means of modifying the condition of the organs. Of all the remedial agents at his command, no other enables him with so much certainty to accomplish extensive and radical changes in the actual state of the organs, as the aliment, directed on a thorough knowledge of its properties, and mode of influencing the organic or nutritive actions. He is enabled through its agency, assisted by the various regulations embraced in regimen and hygiene, to revolutionize completely the whole organism, and to effect deep and lasting mutations in the physical, and even moral nature of man. This result he can operate, by having at command the material elements of our composition, derived from external supplies, and withholding, supplying, or regulating them

according to the existing indications. But, it is evident, that to fulfil a design of so much extent, and to perfect changes so completely radical, a persevering and undeviating adherence to a systematized alimentary regimen, is indispensable.

In acute diseases the basis of the treatment must, in all cases, repose on dietetic regulations; inattention to which will defeat every remedial scheme. In chronic diseases, regimen must compose the principal treatment. Medicinal prescription is a secondary consideration; it is to be invoked only as adjutory, to relieve certain symptoms, and is always to be regarded as merely subservient to the more important and profounder operations the economy can be made to sustain by dietary proceedings.

Drinks are a variety of aliment. They are the liquids introduced into the stomach for the reparation of the fluid parts of the blood, to quench thirst, and to stimulate the organs of the economy. They are of various kinds, are derived from the mineral, vegetable, and animal kingdoms, and are possessed of properties, the most different in their nature.

The natural drinks of man are water, and the acidulous and saccharine juices of fruits and some vegetables, as of the orange, lemon, melon, &c. But man has invented artificial drinks, possessing, besides their qualities as drinks, various properties; all of them are more or less stimulant, and some are nutritive. These drinks are obtained by the process of fermentation; as wine, cider, beer, porter, &c.: by the distillation of fermented liquors; as the various alcoholic liquors: or infusions of vegetable leaves, seeds, &c.; as tea, coffee, &c.

Drinks have some few properties in common. They allay thirst; they dilute the alimentary bolus in the stomach; they assist in the reduction of the compactness of the food; and repair momentarily the losses sustained by the fluids of the economy. They differ most widely as to their especial properties, and the effects they produce in the organism.

The simple and natural drinks fulfil most completely the objects required in the use of drinks, and the habitual consumption of which is most certainly productive of health and longevity. They are the only drinks that can be employed by those of the sanguine and nervous temperaments, for constant use, without entailing most serious and distressing affections. In all inflamma-

tory diseases, they are the only drinks that can be administered, and nature dictates their propriety, by the desire she creates for them.

The temperature of these drinks influences their effects on the economy. Cold water is sedative, but, if the temperature be very low, it often causes a reaction. In febrile diseases, it should be given moderately cold, or when iced, only in small quantities, and very frequently repeated. When highly charged with carbonic acid gas, its sedative effects are enhanced, and it is the most efficacious remedy in allaying the irritation of the stomach. In slight gastric irritations, such as are induced by too stimulating food and drinks, simple, or edulcorated cold water, is the most direct and prompt means to arrest them. Those whose stomach is not excitable, in whom the requisite excitement for the performance of digestion is with difficulty established, suffer from drinking cold water, and their digestion is suspended.

Tepid water causes nausea, and excites vomiting. Its mode of operation in producing this effect is not determined. When it is desirable to evacuate the contents of the stomach, and the activity of emetics is to be apprehended, as in the commencement of gastric fevers, tepid water offers the safest means that can be employed. Hot water, as well as all hot drinks, is stimulant to the stomach, and often excites the skin or kidneys.

Fermented liquors are most of them nutritive, and all more or less stimulant from containing alcohol. They offer peculiar characters derived from the substances they hold in solution. In moderate quantities, they excite mildly the stomach, and in a healthy state of that organ, invigorate digestion; they quicken the circulation, and augment the secretions. On any empty stomach they prove more exciting.

The stimulation of fermented liquors is not limited to the stomach, but is rapidly extended into the whole of the organism. When it is moderate, the increased vigour imparted to the play of the organs, produces a sentiment of force, of activity, and augmented vitality, inspiring feelings of pleasure and gaiety. This forced effort is succeeded by an exhaustion of the organic actions, and a state of languor is induced, corresponding to the extent of the excitement.

Excesses in fermented liquors disturb the functions of the

economy, and, if frequently repeated, inevitably awaken a pathological state. This is more certainly induced in those who are predisposed to diseases, or possess any of their tissues or organs developed in an undue proportion, or have any organ in an irritable condition.

In excess, fermented liquors often occasion inflammation in the stomach. Digestion is arrested, vomitings are induced, and, in the highly irritable and nervous, violent spasms and convulsions are brought on, proceeding from intense gastric sensibility. They excite with energy the heart, inflame it, cause palpitations, and establish fever. The brain suffers no less; all its functions are deranged; the intellectual and moral faculties, from the high and irregular excitement of their organs, and the sanguine congestion its consequence, are incapable of a combined action; false perceptions, violent moral commotions, without a pretext, aberrations of the understanding, followed by a total suspension of intellectual existence, are the effects of this condition. The voluntary powers follow the same course; they are roused into energy, and then sink into languor; the muscles deprived of the stimulation of nervous power, lose their contractile force, and are incapable of supporting the frame; it, then, becomes a mere brute mass: this state is drunkenness.

From the effects experienced by the organs, from the excessive use of fermented liquors, it is not surprising, they are the prolific source of so many maladies, and the cause of numerous of the moral and physical evils of our race. The reiteration of the violent stimulation they induce, terminates in inflammations, either acute or chronic, of the stomach, duodenum, and liver, with the cancerous and other degenerations of these organs. Inflammation of the heart and vessels; the enlargement, and other organic derangement of the one; aneurisms, ossification, &c. of the other, are common results of habitual intemperance. In the brain, its consequences are the production of apoplexies, of convulsions, of mental derangement, and every form of nervous disorder.

Even in moderation, the habitual use of fermented drinks is not tolerated by the sanguine and the nervous. They are unnecessary, and should not be employed by those leading sedentary lives; by those in the vigour of life; when the temperature is moderate; and, when the food is sufficiently stimulating for its own

digestion. They agree with the lymphatic temperament, in which the organs are but little excitable; while engaged in arduous muscular exertions; with those advanced in life; during extremely cold, or excessively warm weather, enervating the forces; and when the quality of the food is not such as to excite the stomach sufficiently for digestion.

Whenever chronic inflammations are seated in any organ, from the diffused excitation they create, fermented drinks are always injurious. They do not relieve the debility attending on the complaint, but aggravate the existing lesion.

Alcoholic liquors are the distilled products of fermented liquors, and contain alcohol in a more concentrated state, combined with some portions of colouring matter, essential oil, and other vegetable principles, imparting peculiarities to the different kinds. They are purely stimulant, being devoid of nutritive properties. All the effects described as resulting from fermented drinks, are caused by alcoholic liquors, but in a more aggravated form, and a more rapid progression. The potency of their stimulation, when taken habitually in excess, soon establishes inflammations in the digestive, circulating, nervous, and secerning organs; disorders their functions; degrades their structure, by the permanent excitement of the organic or nutritive actions, which we have seen to be formative of the structure, (Chap. III. Sect. III.) and thus brutalizes, morally and physically, the human being.

Most commonly the violent aggressions experienced by the organs, from the use of alcoholic drinks, lead to their speedy disorganization, and the early destruction of the miserable victim of this pernicious habit. A very large proportion of the chronic inflammations, that cut off so many of our species, originate in this abuse. Those whose organs are so well constituted, as to resist these attacks for any length of time, exhibit a melancholy picture of human degradation, and are to be regretted more than they who perish. The continued vitiation of the nutritive actions, modifies the structure of the organs, and they adapt themselves, in their sensibility, and mode of existence, to the forced and unnatural stimulation to which they have been so long subjected. It becomes the means of their existence; a return to the natural state would be the loss of function, and death. No option is left them; they must live drunkards, or cease to live. The organs being

physically changed, the moral is altered; and though the outward form is retained, the intimate structure, and the sensibility, have deteriorated, and the being has approached to the nature and character of the brute.

Terrible as are the consequenees of the abuse of alcoholic liquors, the artificial stimulation they create, appears to be an instinctive want of human nature. The discovery of means for this purpose, is coeval with the history of man; and no people, from the lowest savage state, to the most refined civilization, have ever been known to be destitute of them. It is, then, in vain to declaim against the use of spirituous drinks, or to attempt the abolishment of their employment. A want, that history and experience proclaim as imperious to human nature, cannot be annulled at pleasure. It is their abuse we should endeavour to correct; and this is only to be accomplished by the diffusion of education, and instruction in a system of morals, connecting the actions of man with the integrity of his organs, the enjoyment of health, and possession of happiness, and not consisting in the observance of preceptive and arbitrary maxims, the reason of which is too remote and indefinite to oppose an obstacle to present temptation.

Spirituous liquors are to be used for the same purposes, and under the circumstances indicated when speaking of fermented liquors. They are useful to assist digestion when the food is dificient in exciting properties, and is difficult to digest; to obviate the languor induced by excessive heat and perspiration; or to resist extreme cold: they also animate the frame, and inspire with courage, in emergencies requiring physical exertions, and the encounter of danger.

The proportion of spirituous drinks for healthy and invigorating excitement, is about an ounce to a pint of water; in this degree they prove refreshing, and strengthening when the frame is sinking with lassitude.

The nervous and sanguine temperaments are intolerant of the stimulation of alcoholic drinks; and they should be taken very sparingly by those who have these endowments. The lymphatic temperament will long endure their excitement, without suffering serious derangement of the organs.

Alcoholic drinks should rarely be taken on an empty stomach. They are, then, much more exciting; and, besides, the stomach is

stimulated, without an object for the exercise of its augmented energy, and its force is in consequence wasted, for the whole economy.

Coffee and *tea* are vegetable infusions, possessing stimulant without nutritive properties. They differ from the preceding stimulant drinks, by never causing congestions, deranging violently the functions of the organs, or producing confusion of ideas, and suspension of the intellectual operations.

Coffee is an active stimulant, diffusing throughout the organism a pleasant and lively excitation. The animating effects of coffee are notably exhibited in the activity it imparts to the intellectual operations. This circumstance has made it a favourite with the literati, and obtained for it the appellation of an intellectual beverage. It is not, however, a stimulant of the brain alone, but the heart, the stomach, and principal viscera, experience its excitant qualities equally with the brain.

Coffee in its properties is a cordial, and should be employed as such, and not as an aliment. Its use as an article of food, and as forming the principal part of a meal, is a common cause of dyspepsia, by temporarily stimulating the stomach, without presenting solid aliment for the occupation of the increased action it has induced. In this respect it excites the economy to its loss. It is incompatible with all diseases of irritation, and with all local affections capable of exciting febrile disturbance.

Tea, in its effects, has a close resemblance to coffee. It is stimulant without being nutritive. The excitement it occasions is less intense than that of coffee, and it may be used with greater impunity.

Sect. II.—*Apparatus of Digestion.*

The apparatus of digestion presents degrees of complicateness, corresponding to the greater or less simplicity of the digestive process. In some animals it is a simple sack, with a single opening; or a tube, which is the body of the animal; and so closely does it approximate to vegetables in its character, that it may be turned, and the external surface performs, then, the digestive function.

In man, and the mammalia, this apparatus consists of numerous

organs, each having a distinct office, yet the conjoined operation of all is required for the regular performance of digestion. It is composed of a canal commencing with the mouth, and terminating at the anus, traversing the body, formed of different tunics or tissues, and in its course presenting various enlargements, which may be regarded as so many successive cavities united together. These cavities are the mouth, the pharynx and œsophagus, the stomach, and the intestines. Connected with this canal are other organs, pouring into it the products of their secretion, and which are the immediate agents in executing this process. Each of these portions of the apparatus will require a general examination.

§ 1. *The Mouth.*

This cavity concurs in respiration, articulation, and deglutition; it is the seat of gustation or tasting; and is the agent of mastication. In this last respect, it is chiefly attached to digestion. Mastication is effected by the teeth, placed in the jaws, the inferior of which is moveable. The teeth vary in their form and uses. Some are constructed for the purpose of cutting and tearing; such are the teeth of carnivorous animals, and the incisors and canine of man. Animal food being easily resolvable into the nutritive elements by the digestive fluids, does not require to be ground down into minute particles, and its structure entirely destroyed, before they can act on it. Teeth for that object would have been superfluous. Other teeth are formed in a manner to bruise, divide, and grind the food into a paste—these are the teeth of herbivorous animals, and the molar teeth of the human species. Vegetable food cannot admit the action of the digestive fluids, and yield its nutritive principles, unless in the most minute division. The teeth are, consequently, a certain index to the character of the animal, and establish the fact, that man is omnivorous, as he has teeth adapted both to animal and vegetable food.

The insalivation of the food, or its impregnation with saliva, occurs during mastication. The stimulus of the food causes a free secretion of saliva, which is poured into the mouth, and the aliment, divided and contunded by the teeth, is worked up into a pasty consistence. It is also mixed with the fluids of the mucous

membrane of the mouth. The food being prepared, in this manner, is forced by the tongue into the posterior part of the mouth or fauces, whence it passes into the pharynx and œsophagus.

Mastication is important in facilitating the process of digestion, and defective teeth, or their loss, is not an unfrequent cause of indigestion, of disordered states of the stomach, and consequent ill health.

§ 2. *Pharynx and Œsophagus.*

The pharynx and œsophagus are muscular and membranous tubes; the first resembling a funnel. They are, properly speaking, the commencement of the alimentary canal, and lead from the mouth into the stomach. They are lined internally by mucous tissue, which exhales an albuminous fluid, and secretes a mucus from its numerous follicles: these may probably aid in diluting the food, and assist in digestion.

The alimentary bolus is received from the mouth into the pharynx, and conducted by the contractions of its muscular tunic into the œsophagus, along which it is carried by the same means into the stomach. The muscular motions propelling the mass from the mouth into the pharynx, are entirely voluntary; in the upper part of the pharynx volition exercises some control, but in the lower portion, and in the œsophagus, the muscular motions are wholly involuntary.

The inflammation of the mucous membrane of the pharynx and œsophagus, renders the contractions of their muscular tunics very painful; and deglutition becomes difficult, or impossible. They are also spasmodically affected in hydrophobia, hysteria, &c.

§ 3. *Of the Stomach.*

The stomach is an enlargement of the alimentary canal, forming a hollow viscus, immediately succeeding to the œsophagus, to which it communicates by its cardiac orifice. In this cavity the aliment is detained some hours, where it undergoes an entire modification, being converted into a pultaceous mass, called chyme.

The stomach is placed in the upper part of the abdomen, lying obliquely transverse; its large rounded extremity to the left, and

its small, somewhat conical extremity to the right. It occupies all of the left hypochondrium, the epigastrium, and a portion of the right hypochondrium. I have met, in two instances, the stomach in a vertical position, parallel to the spine. Both subjects were emaciated; had insatiable appetite for food; one of them suffered with dyspepsia for many years; and both died with chronic inflammation and ulceration of the ileo-cœcal region of the intestines, attended with diarrhœa.

By its anterior surface, which is convex, and somewhat superior, the stomach is in contact with the liver; by its posterior surface, with the diaphragm; and in front, with the abdominal parietes. It is thus subjected to constant agitation by the movements of respiration, and experiences more or less of mechanical compression in coughing and vomiting. When distended, it must, from its position, resist the descent of the diaphragm; and hence a full meal, or flatus in the stomach, is the cause of so much distress to those who have dilation of the heart, effusions into the thorax, or other affections contracting its capacity. It is this circumstance also, that occasions frequently irritations to be developed in the stomach, and the digestion to be disturbed in those troubled with severe coughs.

The stomach communicates with the œsophagus, towards its large extremity, by an orifice called cardia, and which is not furnished with any valvular structure. At its small extremity it opens into the intestine by an orifice, named pylorus. Around this orifice is a circular enlargement, formed by a fold of mucous membrane, and projecting into the cavity of the intestine, forming an imperfect valve: it is called the valve of the pylorus.

The stomach, the same as the rest of the alimentary canal, is composed of two tunics; the inner one, mucous tissue, and that exterior to it, muscular, composed of layers of muscular fibres. In treating of the mucous tissues, that of the stomach was described; it is disposed irregularly in folds, radiated towards the cardiac orifice, and longitudinally towards the pylorus. It is most delicate in the cardiac extremity, and is thicker and more fungous as it approaches the pylorus.

The mucous coat of the stomach exhibits numerous villi, whence it is named by some anatomists, a villous coat, and contains immense quantities of follicles, especially towards the py-

loric orifice. From the villi, a fluid, said to be albuminous, is exhaled; and the follicles secrete mucus. No other source of a gastric fluid exists than these, and they do not appear to be different from the same structures, in other portions of the mucous tissue. This circumstance renders exceedingly equivocal the existence of a specific gastric juice, the pretended solvent of the food. It certainly cannot be furnished by the follicles known to yield the mucus found in the stomach; and it is not likely, a product possessing the peculiar properties, and executing the important office attributed to the assumed gastric juice, would be formed by a mere exhalation, similar to the perspiration, and the other exhaled simple fluids. It would be a perfect anomaly in the economy of nature; for, whenever a fluid having specific properties, and destined to important offices, is to be formed, a complex secretory apparatus is appropriated to that purpose.

The muscular tunic is disposed in three layers, external, middle, and internal; and is composed of delicate white fibres. This coat is not as thick and as strong as the same coat in the pharynx and œsophagus; and it is less dense in the cardiac, than the pyloric extremity. It does not appear capable of great efforts.

Besides the above, which are the proper coats of the stomach, it has an exterior lining, similar to all the viscera of the abdomen, derived from the peritoneum. This last serves to fix the stomach in the abdominal cavity.

The interior capacity of the stomach varies, with its contents, to which it always in health adapts itself. It is not the same in different individuals, whose habits influence its size; and in some morbid states, it is probably unnaturally distended by flatus, or very considerably relaxed.

The stomachs of carnivorous animals, as their aliment is readily reduced into the nutritive elements, and does not require a long process for this purpose, is small, and the œsophagus enters it near to the left extremity. In herbivorous animals, the stomach is large, and the œsophagus is inserted more towards the right, approaching to the pylorus. The cardiac extremity, in consequence, forms as it were a large pouch capable of containing a conderable quantity of food. In the ruminant animals, the stomach is composed of four parts, and which are commonly regarded as

four separate stomachs. The stomach of man is intermediate between the two; another evidence of his omnivorous character.

The stomach is highly vascular, being richly supplied with blood-vessels, and it receives two kinds of nerves; branches of the eighth pair, and of the ganglionic system, from the cœliac plexus.

§ 4. *Of the Intestinal Tube.*

The intestinal cavity immediately succeeds to the stomach, and extends to the anus. Its length, which is always considerable, varies in different animals, being longest in the herbivorous animals. In man, it is six to eight times the length of his body; but, by the mode in which it is arranged, on the circumference of the mesentery, forming numerous convolutions, it is easily contained in the cavity of the abdomen.

In its general structure, it corresponds with the other portions of the alimentary canal, consisting of a mucous tissue internally, and a muscular tissue external to the first. On the exterior, it is covered by a serous coat, a portion of the peritoneal membrane, common to all the abdominal viscera.

The mucous tunic has a velvety aspect, and is the seat, like the other mucous tissues of a watery exhalation or perspiration derived from its exhalents, and of a mucus secretion proceeding from its follicles. The muscular membrane is composed of an internal layer of circular fibres; and an external layer of longitudinal fibres. These fibres are white; they belong to the involuntary system of muscles, and are excited into contraction by impressions on the mucous tissue. They cause the peristaltic movement of the intestines, and evacuate its contents. The peritoneal coating gives consistency and support to the intestinal tube; and by its lubricity, admits the gliding on each other, and unfolding of the convolutions, necessary to the passage of the contents along the course of the tube. When this tissue is inflamed, its polished and smooth surface is destroyed, its secretion is changed in character, and loses its lubricating properties: the peristaltic motions are impeded; and hence the costiveness attending peritoneal inflammation, and the impropriety of the practice so generally adopted of administering active cathartics in that disease.

The intestinal tube is not perfectly uniform throughout its extent; and different offices are the appropriated duties of different portions. It offers consequently subdivisions. The first two-thirds are smaller in diameter than the last third; whence the first has been termed small, and the last large intestine. The small intestine is the seat of chylification, and the absorption of chyle, or the nutritive elements of the aliments; the large intestine is chiefly the reservoir, and the excretory passage of the fecal matters. This is a natural and well-defined division; and the two are further separated by a valvular structure placed at their point of union, admitting the easy passage of the contents of the small, into the large intestine, and resisting their return. The small intestine has been further divided into three others; the duodenum, the jejunum, and the ileum; and the large intestine has likewise been distinguished into three; the cœcum, colon, and rectum.

This last division is not of much importance, yet each calls for some separate observations.

a. Duodenum.

This intestine may with propriety be regarded as a second stomach, and as rivalling that organ in the importance of its office. The fluids of the liver and pancreas are received into it, are applied to the digested mass as it passes from the stomach, and accomplish the principal object of the digestive process, the separation of the nutritive elements in the form of chyle, from the innutritive materials, which assume in their progress the character of fecal matters. In the duodenum is thus performed, as it were, a second digestion, the completion of the first, or that effected in the stomach.

The name it bears is derived from its length; that being estimated at twelve fingers breadth. It is placed in the middle of the abdomen, deeply seated, in contact with the spine: in its course, commencing at the pyloric extremity of the stomach, it describes a semicircle, having its convexity to the right, and its concavity to the left, and partly enclosing the pancreas.

The duodenum has its interior, or mucous tunic, disposed into numerous folds, constituting the valvulæ conniventes; they are

larger than in any other portion of the small intestine, so that its surface, by this arrangement, is rendered very extensive, notwithstanding its moderate length. This coat is formed of villi, which are exhaling and absorbing from their structure; and contains also numerous follicles, secreting a lubrifying mucus. The serous covering the duodenum receives from the peritoneum, does not envelope the whole of the intestine. It passes over a portion of it, where the common duct of the liver and pancreas enters, securing it firmly, and preventing it from motion, which would have constantly endangered the rupture of those ducts: the portion placed between the laminæ of the transverse mesocolon, has no serous covering whatever. From these circumstances, together with its form, and disposition, the duodenum is susceptible of considerable distention; and when excessively overloaded with the digested or chymous mass, is the cause of peculiar symptoms attending on some of the forms of dyspepsia or indigestion.

The ducts of the liver and pancreas, enter the duodenum about five fingers breadth from its commencement, sometimes by a common mouth, and, occasionally, by separate openings, in contact with each other. The mucous membrane of the duodenum is continuous through these ducts into the glands. In the fœtal state, the ducts proceeding from the intestine, and divided into ramifications, is the first element in the formation of the glands, and around which the vessels and parenchymatous structure are subsequently formed. Hence it is exceedingly probable, that the mucous tissue of the excretory ducts, ramifying through the liver and pancreas, is the immediate seat of their respective secretions, and being continuous from the mucous tissue of the duodenum, the impressions and actions excited on it, are extended into those glands.

b. Jejunum and Ileum.

These intestines commence with the termination of the duodenum, but without any visible separation. Their length is considerable, forming three-fourths of the whole canal; they occupy the middle and greater portion of the abdomen, being thrown into numerous circumvolutions, and are surrounded by the large in-

testine, in which they terminate by a valvular orifice in the right iliac region.

The jejunum is so called because it is always found empty, and is the first succeeding the duodenum. The ileum derives its appellation from its numerous windings; but there is no appreciable line of demarcation between the two: it is preferable, with Haller and Desault, to regard them as one intestine.

The mucous membrane in the superior portion, is disposed so as to form valvulæ conniventes; but these disappear towards the inferior portion, and in the ileum are replaced by simple wrinkles. The intimate texture is nearly the same as the rest of the intestinal mucous tissue, having exhalent or perspiratory vessels, and numerous mucous follicles. These last, called glands of Peyer, and of Brunner, are most abundant in the lower portion of the ileum, especially the last third, and in the vicinity of the ileo-cœcal valve, while the chylous and exhalent villosities diminish. This circumstance, it is presumable, is the cause of the frequency, with which inflammation of this portion of the tube, causes the appearance of circumscribed, thickened, or elevated patches, or laminæ, readily running into ulceration, and so common in this situation. These laminæ are composed of follicles, which here are so very abundant, enlarged and indurated by inflammation. This is the whole secret of the Dothinenteritis of Bretonneau.

At the junction of the ileum with the cœcum, is a valvular structure. It appears to be formed by the first being prolonged, or projecting through an aperture in the last, in the cavity of which it makes a soft elliptical prominence, having a labiated opening in its centre. This arrangement produces a contraction of the intestinal tube, at this point, where the fecal matters must be detained. This may also be another cause of the frequency of the inflammation, thickening, and ulceration, dissection so constantly shows to occur at this position, and to be so common in protracted fevers, and those of typhoid character.

c. Large Intestine, or Cœcum, Colon, and Rectum.

The large intestine, so called from its greater caliber, terminates the alimentary canal; it is much shorter than the small,

forming scarcely a fifth of the whole intestinal tube. It commences in the right iliac region, ascends in the right flank, before the kidney, until it reaches the liver; then, traverses the abdomen, redescends along the left flank to the left iliac region, where it makes a flexure to gain the sacrum, and plunges into the pelvis, finishing at the anus. In its course it is not floating loosely like the mass of the small intestines, but, at its commencement and termination, it is firmly attached to the parietes of the abdomen. Three divisions have been made of the large intestine, cœcum, colon, and rectum; but, as no line of separation distinguishes them, or any known distinction between them exists, no separate description will be made.

The commencement of the large intestine in the right iliac region, is called the cœcum: it receives the termination of the ileum in its middle, and not at its extremity, and thus forms a kind of pouch, or cul-de-sac, below that opening. The fecal matters, from the influence of gravity, must frequently be detained in this situation: this circumstance may be a cause of the frequent occurrence of ulceration in the cœcum.

The division named colon, forms the greater portion of the large intestine; it forms nearly a circle, surrounding the small intestines, and following almost the circumference of the abdomen. It is distinguished into ascending, transverse, or arch of the colon, descending colon, and sigmoid flexure. The last division, or the rectum, terminates the intestinal canal. It descends perpendicularly, following the concavity of the sacrum and coccyx, and ends in the anus.

The general structure of the large intestine, is analogous to that of the rest of the alimentary canal, yet it offers peculiarities in its arrangement, that distinguish it by some features. In its mucous membrane the villosities disappear; it is smoother, and has less of the fungous and velvety aspect presented by the mucous tissue of the small intestines. The follicles are, also, more numerous; for, as the excremental matters in the large intestine acquire consistency, they require it should be freely lubricated to admit their passage. The follicles are not collected as in the ileum, on a part of its diameter, but are disseminated over its surface, and, hence, the ulcerations of the large intestine are scattered over every part, and laminæ are rarely met with in it. The

follicles are, often, found destroyed by ulceration, to such an extent that the mucous membrane of the colon and rectum appears perforated with innumerable foramina, like a colander. From this cause also inflammation of the mucous tissue of the large intestine commonly occasions mucous stools.

The muscular fibres are disposed differently in the large, than in the small intestines; the longitudinal fibres are collected into three bands, and being shorter than the intestine, contract it, and form its interior into imperfect cells, giving it the irregularly crimpled aspect it is seen to possess. In the rectum the fibres are much more numerous and stronger, and its termination, like the commencement of the alimentary canal, is surrounded by muscles under the control of the will.

The rectum is covered by the peritoneal membrane in its upper portion only; whence it is liable to considerable distention in its lower portion, which sometimes becomes enlarged into a considerable pouch, by the collection of indurated fecal matters.

§ 5. *Of the Secretory Organs, and Fluids concerned in Digestion.*

The digestive organs hereunto described, do not constitute the sole apparatus of digestion. They form rather the vessels, or laboratory, in which the food undergoes the physico-chemical operations, by which its physical and chemical characters are subdued, and it is reduced to elements, susceptible of becoming organized, and of acquiring a capacity for vital phenomena.

The immediate and principal agents effectuating these operations, are the apparatus, and the peculiar fluids now to be described. This apparatus consists of the salivary glands, the liver, and pancreas, and the fluids they respectively secern.

a. Salivary Glands.

These glands are placed in the vicinity of the organs of mastication, for, in this process the food is impregnated with saliva, while it is finely comminuted. In man, three glands on each side of the mouth, are appropriated to the production of the salivary

fluid: they are, the parotid, the submaxillary, and the sublingual; the excretory ducts of which are continuations of the membrane lining the mouth. In the forming state of the salivary glands, the first rudiments are the ducts and their ramifications, around which the parenchymatous structure is subsequently produced. The salivary glands may, then, be regarded as prolongations of the buccal mucous tissue, with numerous cryptæ, or folliculi, aggregated in a mass. From this view of the formation and structure of the salivary glands, two principles may be established: 1st, that all impressions on the mucous tissue of the mouth, of a certain intensity, are experienced by the salivary glands, and influence the secretion of the saliva; and 2d, that a fluid having all the properties of saliva, and performing its offices, may be secreted from folliculi or cryptæ, without being aggregated into the glandular form.

Hence it is, that all stimulations of the buccal mucous tissue, whether food, condiments, or irritating applications, and its inflammation, cause an increased flow of saliva. Hence also, those animals that do not masticate, as fish, birds, &c. have not proper salivary glands, in the vicinity of the mouth, but numerous small follicular glands are arranged around the pharynx, or at the termination of the œsophagus in the stomach, furnishing the salivary fluid requisite for digestion.

The salivary glands have a magnitude in animals corresponding to the complexity of the digestive process. They are small in carnivorous animals, and in animals whose food is nearly analogous in its elements to those of their own structure. They are large in herbivorous animals, whose digestion is exerted on food differing in its nature from their organs, into which it is to be converted, and which function, in them, is a long and difficult process.

The large apparatus for the production of saliva, its constancy in all animals, and the copiousness of its secretion, are evidences of the importance this fluid possesses in the digestive process.

The saliva in its natural state, is nearly limpid, inodorous, and insipid. It has been conjectured, that the saliva proceeding from the different glands was not exactly the same. This opinion is sustained chiefly on the number of its sources; as it was supposed, nature would not multiply the number of glands, when two on

each side might have sufficed, if mere quantity was the object. But in the provision of important functions, nature often multiplies the organs, to diminish the risks arising from accidents.

The analysis of the saliva does not throw light on its action in the digestive process. The latest and most complete researches, in this respect, are those of Gmelin and Tiedemann. It contains from 1 to 2.5 per cent. of solid parts. These are salivary matter; osmazome, mucus, albumen, phosphorized fat, acetate, carbonate, phosphate, and sulphate of potassa; chloruret and sulpho-cyanuret of potassa. The last is a highly poisonous principle.

The quantity of saliva secreted, cannot be easily estimated, yet, it is very considerable. It is augmented by mastication, by the sight, odour, and taste of savoury food, by the stimulation of condiments, and also by disgusting objects.

During mastication it penetrates the food; and at other times, is constantly swallowed, so that the stomach is, in some respects, a reservoir of the saliva. There is every probability, that no other gastric juice, really exists, than the salivary fluids, mixed with mucous, follicular secretions, and the exhaled or perspired fluids of the gastric mucous membrane.

The secretion of saliva is influenced by the morbid conditions of the stomach. The acute irritations of the gastric mucous membrane, appear to affect, in nearly a similar manner, the mucous tissue of the mouth; its secretion is modified, is viscid, pasty, and forms a crust on the tongue; and, at the same time, the saliva is either deficient or morbidly changed. Hence the thirst of febrile, and all other patients, in whom this secretion, and that of the digestive mucous tissue, is defective.

This secretion is influenced by the passions and moral emotions. On this account, certain of them cause aridity of the mouth and throat, &c.

In animals, the saliva is capable of acquiring highly poisonous qualities, and of generating in the animal economy the most dreadful and formidable of diseases—rabies. This effect on the saliva, it is said, has been produced by irritating animals, and exciting their ferocity. It is not known whether the human saliva is affected in a similar manner.

b. Liver and Bile.

The liver is a large glandular viscus, occupying, beneath the diaphragm, the whole of the right hypochondriac region, and a portion of the left. The product of its secretion is one of the most compound fluids of the economy, called bile; and which performs a conspicuous part in the process of digestion. Other offices have been assigned to the liver, than the mere provision of an agent in the function of digestion; but this is not an appropriate place for a review of the various hypotheses emitted on this subject.

The liver is an organ of exceeding complex structure. It receives blood-vessels appropriated to its nutrition; others destined for its secretion; it is permeated by mucous tissue, disposed in the form of minute canals—the pori biliarii—intimately connected with the biliary secretion; converging into a single vessel, this tissue forms the hepatic duct, opening into the duodenum, and it is, thus, continuous with the mucous tissue of that intestine. From this circumstance, some physiologists have been disposed to regard the liver as an appendage to the duodenum, consisting in ramifications of its mucous membrane. This view is sustained by the fœtal development of the liver, in which the duct, with its ramifications in a soft cellular tissue, first appears: and in some insects the liver presents nearly a similar arrangement. Other physiologists are disposed to adopt another view, and regard the liver as the essential or radical organ of the digestive apparatus, and the duodenum merely as a vessel, or laboratory, in which the biliary secretion may be brought into its appropriate action. The nerves of the liver are chiefly derived from the hepatic plexus of the ganglionic system, with some few filaments of the eight pair. It has a proper coat which penetrates into its interior, and forms sheaths or coverings to the portal vessels, and biliary ducts: and it is protected externally by peritoneal membrane, forming at the same time its attachments to the diaphragm and parietes.

Attached to the under surface of the liver, but having no direct communication with it, is a membranous sac, lined interiorly with a mucous coat, and which constitutes a reservoir for the bile: it communicates with the hepatic duct, by a duct of similar struc-

ture, called the cystic, the two uniting at an acute angle, and below the level of the neck of the gall-bladder. The bile, in passing into this reservoir, must flow in opposition to its gravity. The force accomplishing this effect, or the manner of its production, is unknown. The gall-bladder is usually found distended in those whose digestion has not been put in requisition for some time previous to death; while it is empty, or nearly so, in those who die immediately after, or in the act of digestion. Hence it is supposed, the bile is collected in the gall-bladder, when it is not required for the purposes of digestion.

The situation of the liver abstracts it from the direct impression of most of the exciting agents of irritative actions in our organs. Its diseases are for the most part secondarily induced, either by sympathetic irradiations from other organs, or by disturbance in its functional offices. The stomach, duodenum, and liver, are most intimately associated, through the cœliac, hepatic, and solar plexuses of the ganglionic nerves, and their functions are directly concatenated. It is through the stomach and duodenum, the viscera directly and almost constantly exposed to aggressive impressions, that morbid irritations reach the liver. Most of the symptoms usually ascribed by systematic writers, to diseases of the liver, belong, in fact, to chronic gastritis; and to acute and chronic duodenitis; while some proceed from chronic colitis. The phenomena of these various affections are all grouped indiscriminately together, as symptoms of either acute or chronic hepatitis. To this cause is to be attributed the erroneous diagnosis of the medical attendants of Napoleon, from Dr. O'Meara to Antommarchi; all of whom mistook the clearest signs of chronic gastritis, for hepatitis, and advised for the illustrious captive an incompatible treatment, which his good sense resisted, and induced him to reject. The first lesson I acquired, in prosecuting pathological autopsy, in the Alms-house Infirmary, was, that, in very few of the cases, supposed from their symptoms to be hepatic disease, was the liver in the least affected; while chronic disease of the liver was detected where none of the signs, commonly considered as characteristic of it, had existed. In not a third of the cases, usually regarded as of hepatic origin, is the liver in the slightest degree concerned; and, when it does become involved, it is only consecutively to a gastritis, or a duodenitis, that have been its precur-

sors, and from which it has proceeded, in the majority of instances, from sympathetic irradiation. The continuity of the gastric, and duodenal mucous tissue, into the interior of the liver, is another cause of the propagation of the irritations of the two first organs into the liver, but is a less frequent source of its irritations than sympathy.

The function of the liver is often deranged in the chronic affections of the pulmonary organs, attended with change of their structure. The liver becomes enormously enlarged, in some of those cases, as though it attempted an office vicarious to that of the lungs. In some cases of this kind, I have met with, no signs betrayed the hepatic disorder during life.

Organic affections of the heart, by the interruption experienced in the circulation, and the consequent mechanical congestions frequently established in the liver, often excite chronic irritation and inflammation of that organ.

Bile is the well known fluid secreted by the liver, of yellowish-brown colour, and exceedingly bitter taste. It is collected by the pori biliarii, or ramification of the biliary hepatic duct, which carries it into the duodenum. A portion is conveyed through the cystic duct into the gall-bladder, where it undergoes some modification, and is reserved until called for in the process of digestion. Two kinds of bile, then, exist; the hepatic, or that coming directly from the liver, and the cystic, or that contained in the gall-bladder. This last is more viscid, of a deeper colour, and bitterer taste than the hepatic bile. It is that also which is taken for analysis.

The bile is the most compound of the animal fluids, and offers the least analogy to the blood, from which it is formed. It has been the frequent subject of analysis; yet, from the contradictory results of chemists, much uncertainty prevails as to its constituent elements. Thenard discovered in the bile of the ox, a peculiar resinoid substance—picromel; and its existence in that of man has been verified by Chevreul, Chevalier, and Lassaigne. It contains, besides water and picromel, free soda, with some of its salts, a yellow animal matter, easily putrefiable, and mucus. Tiedemann and Gmelin have indicated several other products, as asparagine, gliadine, &c. But, it is not improbable, that some of these results are produced by the reagents employed, by the action of the

air, and of heat on a fluid of a complex composition, and readily alterable; for it is decomposed by simple exposure to the air.

The most striking characteristic of bile, is its property of neutralizing acids, and of deoxydating certain substances by seizing on their oxygen. These properties are manifested only in fresh bile, as by exposure to atmospheric air, it becomes saturated in a short time with oxygen.

The picromel of the bile is the most important of its principles, and to which it owes its property of neutralizing acids, and deoxydating substances. This principle has a considerable analogy to the resins, and is readily convertible into a resinoid matter by the action of oxygen. In this respect, it approaches somewhat to the vegetable alkaloid principles, as Schultz* has remarked; and confers on the bile the chief of its alkaline properties.

The bile, there are grounds to believe, is not exclusively employed in digestion, but is somewhat recremental; the liver partaking in a certain degree of the excretory character of the lungs, and eliminating nearly a similar element from the economy—viz. carbon. This difference, however, prevails between them: the lungs reject carbon in the gaseous state; while the liver throws it off, in conjunction with hydrogen and azote, in a solid form. That the bile is in part recremental, may be inferred, as in some animals, the Cephalopoda, and the genus Doris, belonging to the Mollusca, a distinct excretory duct, proceeds from the liver to the anus.

The bile is accused, like the liver, of causing innumerable mischiefs, and occasioning extensive morbid derangements in the economy, of which it is entirely innocent. Great exaggeration prevails, in this respect, not only with the populace, but with the profession. It may be undoubtedly true, that a morbid condition of the liver may produce a biliary secretion of a vitiated character, and which may prove irritating to the alimentary canal, and disturbing to the digestive organs; but, I am thoroughly convinced, this is a circumstance of rare occurrence. The morbid condition, to which the term "bilious" is commonly applied, is gastric and duodenal irritation, induced, generally, by excessive repletion, or improper aliment; and often maintained by the frequent

* Journal des Progrès, tome v. p. 72.

employment of purgatives and mercurials, affording a temporary, but delusive relief, by the secretory evacuation they excite. Black stools, on which so much stress is laid, and which are, with general accord, regarded as certain indications of a morbid state of the biliary apparatus and secretion, I confidently aver, are, in most instances, wholly independent of the bile. In acute fevers they proceed from the secretions of the intestinal mucous tissue, especially when they are violently urged by active cathartics: and when mercurial purges are employed, the passages are invariably rendered black, by the protoxide of mercury formed in the bowels, until it has been purged off, when they frequently assume another aspect. It is only in very intense attacks, that the alvine discharges will exhibit other than a natural *colour*, if active purging be abstained from. They drive on the secretions of the inflamed and irritated surface of the intestines, until they are wholly perverted, and entirely changed from their natural state. I feel confidence on this point, from the results of attentive observation, and experience in hospital and private practice.

c. *Of the Pancreas, and the Pancreatic Liquor.*

This gland is less constantly found in animals than the liver. In structure it bears a strong analogy to the salivary glands, and it has generally been regarded as similar to them in every respect. It is placed in the concavity of the duodenum, into which its duct terminates, without having a connexion with any reservoir. Its secretion must, consequently, be continually poured into the duodenum, or be secreted only during the excitement of digestion, like the milk, which is secreted principally in the act of lactation.

The nature of the pancreatic liquor has been rather conjectured, than positively determined. It has generally been asserted, that it is the same as the salivary fluid. The difficulty of procuring this liquid has placed obstacles almost insurmountable to a knowledge of its real character, and its uses. Leuret and Lassaigne, in accordance with most physiologists of the age, have asserted it to be similar to the saliva. Messrs. Tiedemann and Gmelin detail an analysis, on the contrary, exhibiting principles entirely different from those of the saliva. In the present state of

our information, no positive opinion can be formed on this subject; but the probabilities are strongly in favour of a difference in the nature of the pancreatic and salivary fluids.

Of the precise use of the pancreatic liquor in digestion, it is not possible to form more than probable conjectures, in the absence of all positive knowledge, or well-determined facts in relation to it. In most of the inferior animals a proper pancreas, analogous in structure to that of man, is deficient, and it is only in the three superior classes of animals in which it is found.

The diseases of the pancreas are but little known, and the influence its morbid conditions exercise over the functions of the economy are yet undetermined. A patient in the Alms-house Infirmary had been affected with chronic dysentery for several months. He was cured of this disease, the bowels performed their functions naturally, his appetite was good, and digestion did not appear to be disordered. Yet he continued slowly to emaciate, and died in complete marasmus. On examination, the alimentary mucous tissue exhibited a natural structure, except the cicatrices of the ulcers formerly existing in the large intestine, and part of the ileum: these were of a deep black hue. The pancreas was enlarged and indurated: the remaining digestive organs were natural. This case would appear to indicate, that the pancreatic fluid is essential to the completion of the digestive process.

d. Gastric Juice.

The existence of a special fluid, possessed of solvent powers, and accomplishing digestion, is an hypothesis assumed, rather than a demonstrated fact. Spallanzani having, by his admirable experiments on digestion, attempted to disprove the, then, admitted doctrines of trituration, maceration, putrefaction, &c. as the efficient agents of digestion, imagined a peculiar fluid, he named gastric juice, as the means of its performance. This fluid, he conjectured, acted in the manner of a chemical solvent, was always identical, and accumulated in the stomach during fasting. This hypothesis was very generally received, is adopted by most physiologists of the present day, and often governs the practice of physicians in the treatment of indigestion: yet, it cannot be denied, that the evidence on which it reposes is slight and incon-

clusive. Its correctness has been challenged, first, by M. de Montègre, and subsequently, by M. Chaussier, whose experiments and observations are conclusive against the existence of a gastric juice, such as is supposed by Spallanzani.

Many attempts have been made to analyze the assumed gastric juice, and to determine its specific characters, but they have all failed in the contemplated object. M. de Montègre, who was gifted with the power of evacuating his stomach at pleasure, and could, thus, collect the fluid of the stomach, found it to differ very little from saliva. When it was not acid, it, then, resembled perfectly pure saliva; and when it was acid, it appeared merely as a modification that fluid had undergone in the stomach. Tiedemann and Gmelin, in their highly interesting researches on digestion, renew the doctrine of Spallanzani, and suppose a special fluid to be secreted by the stomach during the act of digestion, by which the aliment is dissolved. This inference is adopted from the small quantity of fluid found in the stomach after prolonged fasting; and its acid character, when its secretion has been excited by mechanical irritation, or the stimulus of aliment; a character that does not belong to saliva. Notwithstanding the authority of those able investigators, sustained also by the similar opinion of MM. Leuret and Lassaigne, I am still disposed to doubt the reality of a special gastric fluid, and to regard the assumed gastric juice as no other than the saliva, swallowed and mixed with the secreted mucus and exhaled fluids of the mouth, pharynx, œsophagus, and stomach.

That the stomach should contain but very little fluid after fasting is to be expected. The salivary secretion is always greatest during digestion; and when this process is suspended, the natural stimulation of all the digestive apparatus, soliciting the requisite secretions, being absent, those secretions are either diminished or suspended. In fasting, also, a morbid irritation most generally is excited by the pain of hunger in the stomach, involving all the digestive apparatus, and affecting their secretory actions. Hence, in long fasting, febrile irritation arises, the mouth is pasty, and sometimes even arid, from the deficiency of the saliva. The absence of fluid in the stomach after prolonged fasting, is not, therefore, a proof that saliva does not accumulate in the stomach for the purposes of digestion, but, that it ceases to be secreted, in

any quantity, during that period. If the secretion of the salivary fluid be not suspended, it must either be rejected, or it must pass into the stomach.

The presence of acids in the fluid found in the stomach, when it is mechanically irritated, as by pebbles, &c. and its appearance during digestion, are not of sufficient conclusiveness to warrant the inference of a special gastric juice. The mucous tissues very generally produce acid secretions when irritated; this fact is evidenced in the secretion of the nasal mucous tissue in acute catarrh; of the bronchial mucous tissue in bronchitis; and in the intestinal mucous tissue in some cases of diarrhœa and dysentery. It is almost constant in the bowels of children, and causes the green stools so frequently observed in them, from the action of the acid on the colouring matter of the bile. Now, it was observed by Montègre, that the fluid of the stomach was not acid previous to digestion, but that acid was manifested when food was in the stomach, and, consequently, exposed to irritation. Tiedemann and Gmelin confirm this observation, for they found, when the stomach was not mechanically irritated, the fluid in the stomach was often free from muriatic acid.

In addition, it may be remarked, that the acidity of the fluid of the stomach, does not appear to be connected with its digestive powers; for, its unusual increase, instead of augmenting its energies in that respect, operates reversely, and enfeebles them. The dyspeptic, who suffer from acidity of the stomach, cannot digest with facility, until the acid is neutralized by alkalies, or some calcareous preparation. It is, then, even doubtful, whether the acid developed in digestion is essential to that process; or is merely a concurrent effect arising out of the irritation the exercise of the function necessarily provokes.

The principal acid detected in the fluid of the stomach is the hydro-chloric or muriatic, as announced first by Prout, and since confirmed by Tiedemann and Gmelin: these last have also ascertained the presence of acetic, or the lactic acid, (Berzelius has shown them to be identical,) and in horses, butyric acid.

From all the researches as yet instituted into the nature of the gastric juice, it does not appear to me, we are authorized to assume the existence of a special gastric juice, endowed with peculiar and solvent properties for the performance of digestion. The

absence of a special apparatus for its secretion, has already been noticed as an anomaly; and, it is generally true, that, what are supposed to be anomalies in nature, or violations of a general law, are, in reality, founded in an ignorance of the facts, or on suppositious facts not truly existing. That the saliva, which, on the supposition of a solvent gastric juice, would be of no other use than to moisten the food, should have provided for its secretion a large glandular apparatus, while the more important fluid, the gastric juice, should be a mere exhalation, would be an anomaly violating grossly the general phenomena of the animal organism. The presumed gastric juice is, then, we are justified in concluding, no other than the salivary, buccal, pharyngeal, œsophagial, and stomachical follicular secretions and exhalations, collected in the stomach.

Sect. III.—*Process of Digestion.*

From the view presented of the apparatus executing the function of digestion, it is apparent, that this is not a simple and a single process, but is composed of several and distinct operations. The object of this function is to destroy the physical and chemical attributes of the aliment; to divorce the nutritive principles from their connexion with other matters; and, thus, to prepare them for admission into the interior of the organism, and their appropriation to the structure of the organs by nutrition. Digestion, consequently, consists in all the changes the aliment undergoes in the digestive apparatus, from its reception in the mouth, to the expulsion of its residue from the anus.

Digestion is exclusively an animal function: vegetables exhibit nothing of a similar nature. The processes of fermentation and putrefaction, perfect in the soil, the changes, in their alimentary matters, requisite to adapt them to the nutrition of the plant. The nutritive principles are elaborated exterior to them, and are presented to their roots, or absorbing apparatus, prepared, independent of any operation of their economy, for the purposes of their nutrition. The changes the food of animals must undergo preparatory to its employment in nutrition, are accomplished within their economy, and are executed by the apparatus and process of digestion. In vegetables the operation is purely che-

mical; in animals it is physical and chemical, but combined with, directed and modified by vital phenomena.

The changes experienced by the aliment in the process of digestion, may be included under the heads of chymification, chylification, and fecation.

§ 1. *Chymification.*

The food, comminuted by mastication, impregnated with the salivary and buccal secretions, and formed into a bolus by the tongue, is carried into the stomach through the œsophagus. This organ readily expands as the food arrives in it, until a certain degree of distention is acquired, when its farther enlargement becomes a source of uncomfortable or painful sensation to itself, and of embarrassment to other organs by its pressure on them: the further ingestion of food becomes difficult, and cannot be made without considerable effort.

The food, as it arrives in the stomach, accumulates there, and experiences a detention of some hours, varying according to its nature. During this period it suffers an entire change, in which consists chymification. The food is prevented from regurgitating into the œsophagus by the contraction of its muscles: when these are relaxed, or are paralysed, as in the division of the eighth pair of nerves, the food regurgitates into the œsophagus. It is prevented from passing through the pylorus, by the contraction of its circular fibres, and the peristaltic contractions proceeding from the duodenum towards the pylorus, which repel and confine the undigested aliment.

The food arrived in the stomach, is saturated with the fluids contained in it, and which are constantly increased by the excitement it occasions. The first effect of the food on the stomach, is to produce this excitement, and an increase of secretion. The force of the excitement is determined by the quantity and quality of the food, and the irritability of the stomach. In the act of digestion, as a consequence of the excitement of the mucous tissue of the stomach by the contact of the food, it becomes a centre of affluxion; the sanguine humour is directed towards it; its circulation is accelerated; its secretions are increased; its animal heat augmented; and all its vital phenomena are elevated.

Soon after the food is received into the stomach, a succession of alternate contractions and relaxations, commencing at the pylorus, and directed towards the cardiac extremity, ensue. By this species of vermicular motion, named peristole, the food is maintained in constant agitation, is mixed up and imbued with the gastric fluids, and is kept in contact with the parietes of the stomach. The force of these contractions is greatest when the stomach is distended with aliment. Bichat found it was, then, sufficient to force pieces of cartilages contained in small balls, that dogs were made to swallow, from their interior; whereas this effect did not occur when the stomach contained but little food.

This contractile force, and the peristaltic movement of the stomach, exercise a compression on the alimentary mass directed from every point of the circumference towards the centre, and from the pylorus towards the cardiac extremity. As a consequence of these actions, the denser and more resisting part of the food, that is—the least digested—is pressed towards the centre, and the cardiac extremity, while the least resisting and more fluid portion, or that which is most digested, is forced between the particles of the other portion, and is found on the circumference in contact with the parietes of the stomach, and around the pylorus. This circumstance is a purely physical result; yet, it has led Dr. Philip, and other physiologists, to adopt a wrong conclusion. They have laid it down as a principle, that digestion takes place only on the circumference of the alimentary mass in immediate contact with the parietes of the stomach, and that it is never effected in the centre.

The food in the stomach is subjected to a temperature of from 100 to 102° Fahr. This circumstance, and the constant agitation it experiences, are important aids in digestion. At the same time a constant supply of the fluids concerned in digestion, is an indispensable requisite for its regular performance.

The alimentary mass, placed in the circumstances mentioned, and it is not improbable, acted on by influences not yet fully appreciated, undergoes a gradual change; it loses its cohesion and consistency, and is converted into a pultaceous, grayish, and, apparently, homogeneous, and viscid substance, having a sweetish, stale, and somewhat acid taste. This mass is called chyme, and,

according to Tiedemann and Gmelin, always exhibits with re-agents the presence of an acid.

In the cardiac or splenic extremity, chyme is barely seen, but increases towards the pylorus, at which extremity the contents are almost entirely chymous.

Chymification invites attention in two points of view; 1st, as to the process itself; what is its nature: and 2d, as to the means accomplishing it.

On both these points our knowledge of the facts of chymification is too imperfect, and the investigations heretofore made, are too limited and defective to enable us to arrive at certain and positive conclusions. The utmost physiologists can pretend to, is no more than approximations to the truth. A summary of the facts precedingly investigated, connected with this process, may throw some light on its character.—*a*, The proximate elements of the animal tissues and solids are always the same—albumen, fibrin, and gelatin, combined with some earthy salts; these are, even, probably modifications of each other: *b*, these elements when organized, assume a globular form, or that of a coagulable substance: *c*, the number of substances that can serve as aliment is limited, and they have always a similar composition: *d*, the nutritive elements, or principles of the aliment, are still more limited; they are, in part, the same as the proximate elements of the animal tissues, and the remainder approximate to them so nearly, as to become identical with them by slight modifications: *e*, the nutritive principles of the aliment are united with other matters unqualified for nutrition, and from which they must be separated: *f*, the chyme, or the product of gastric digestion, from the same food, is of homogeneous or uniform nature.

From the establishment of the foregoing general facts, the following conclusions are a necessary result—1st, that in the aliment are contained the elements of the animal tissues; 2d, the aliment must be placed in a condition admitting the separation of the nutritive principles from the innutritive matters; 3d, that the physical and chemical characters of the aliment must, consequently, be destroyed; 4th, that the aliment and the nutritive principles being limited, when the physico-chemical characters of the aliment are destroyed, the product from the same food must be homogeneous; 5th, that the chyme is the nutritive principles detached from, but mecha-

nically mixed with the innutritive matters; and 6th, that chymification consists in the reduction of the aliment to this state, and the first preparation of the nutritive elements, qualifying them to be reorganized; or to become the proximate elements of the animal tissues.

In examining the chymous mass in the process of digestion, the above conclusions appear to be substantiated. The distinctive characters of the food are, in a great measure, destroyed; and its different principles have been separated from each other. I obtained a portion of the contents of the fourth stomach of an ox. After standing a short period, it separated into a supernatant, turbid liquid, and a feculence. This last was composed of two parts; the first, occupying the surface, was a fine pulp of a dull green hue; and the other, which occupied the bottom, was the insoluble fibres of the hay and straw, that had been the food of the animal.

When the supernatant liquid was examined by Jones' improved microscope, it exhibited numerous minute, flattened globules: these were transparent, but had the appearance of a dark or opaque rim; caused, however, by the refraction of the rays of light. Floating in this liquid were also small masses of an irregular shape, and semitransparent, resembling gelatin. The fine pulp, when inspected by the same instrument, exhibited an infinitely greater number of the above-described globules, and a much larger quantity of the semitransparent gelatinous matter: it appeared to be composed almost entirely of them, mixed with a few vegetable fibres. These globules are similar in their general appearance to those that proceed from animal food, excepting their size; it is much smaller.

The chymous mass of the stomach of a dog, taken at the pyloric extremity, presented the same appearance of transparent globules, intermixed with irregular particles of a semitransparent and gelatiniform substance. The globules were of various size, but numbers of them were double and treble the magnitude of the largest found in the chyme of herbivorous animals. In both, the globules were lighter than the irregular particles; they floated on the surface of the liquid in which they were contained, and required a different focus in order to be distinctly perceived.

Chymification is not, then, a chemical decomposition of the food, resolving it, as some have conjectured, into its ultimate

principles, subsequently recombined to form chyme and chyle. It consists in a separation of the immediate, or proximate constituents of the aliment; a species of proximate analysis. These principles are the same as the proximate elements of the animal structure, or approach to them so closely, as, with a slight modification, to be readily converted into them. They are, consequently, the nutritive principles, and which exist already created in the materials composing our food, and are not an absolute product of the digestive function.

The chyme is, then, the product of the first stage of the analytic process of digestion. The proximate constituents of the food are thrown down, as it were, forming a common precipitate, or mass, no longer in chemical combination, yet not mechanically separated from each other. This last is the result of the second stage of the analytic process, and is accomplished in the duodenum: its product is chyle.

Such being the character of chymification, it remains to be examined, what are the means effecting this process. Various conjectures have been resorted to for an explanation of the phenomena of digestion. Putrefaction, maceration, trituration, fermentation, and solution, have each been suggested as the means of its performance; they have each, in turn, possessed their advocates, and enjoyed for a term a certain celebrity. In the received systems none of them are admitted as entering into the process of digestion. Spallanzani, it is supposed, successfully rebutted the pretensions claimed for them; and, amongst the majority of physiologists, his hypothesis of a specific solvent gastric juice is generally adopted.

That maceration and solution have no agency in the digestive process, is by no means clearly established. It is true, neither, alone, is adequate to digestion, nor, when united, may they be sufficient to its fulfilment; yet, that they concur very actively in the digestive process, I believe, can be shown by very conclusive facts. In the herbivorous animals, the first stomach, or paunch, serves no other purpose, than to macerate the aliment; and in most animals drinks are desired and taken, either with the food, or soon after eating; and digestion is always facilitated by moderate quantities of drink. The food, besides, requires to be steeped in the secreted fluids a certain period before their diges-

tion commences, and, if the secretion of these fluids be suspended, digestion cannot be performed. Maceration is a part of the process of digestion, and is indispensable, as it respects vegetable aliment, in animals to whom it serves as nutriment. In man, it is necessary that most vegetables, before they can serve as aliment, should be subjected to a process having the same effect as maceration; such as boiling, stewing, &c.; or be brought into the same state by their maturation. By maceration, the cohesion of the particles of food is lessened; the aliment is penetrated, and thoroughly imbued with the fluids of the stomach; and is, thus, prepared to undergo the changes accomplished in it.

If the view we have presented of chymification, be correct, solution must perform no inconsiderable part of this process. The nutritive principles existing, ready formed, or nearly so, in the aliment, they require merely to be separated. Those substances, whose principles are not in binary combinations, but in simple aggregation, are susceptible of having them separated, when they are submitted to the action of different fluids, each of which has solvent powers for particular principles. In this manner, all the constituent proximate principles may be obtained separately. Now, in chymification the aliment is subjected in the stomach to the action of different fluids—the salivary, buccal, œsophagian, and gastric secretions. The properties and especial characters of these have not been examined; or their several actions on food been determined. The saliva, I have ascertained positively, does exercise a very energetic operation on the food; separates, by its solvent qualities, some of its constituent principles, and performs a species of digestion. The gastric secretions may exert an action not less powerful, and it is by a process of this nature, it is exceedingly probable, that chymification is accomplished. Chymification would, then, be a purely chemical operation, having a strong analogy to the chemical analysis by which substances are reduced to their proximate elements.

Notwithstanding all that has been done in the investigation of this function, chymification is not yet properly understood, and new researches must be instituted before it can be regarded as finally settled. The hypothesis of Spallanzani, of a single and uniform specific solvent juice, producing, with all the varieties of aliment, a single and constant product, has not been sufficiently

verified by experiment or observation; it has no analogy in nature; and without far more weighty evidence in its favour ought not to be adopted.

During the process of chymification, the alimentary mass is constantly agitated by the peristole of the stomach; the digestive fluids are in this way mingled with the food, and brought incessantly in contact with it. This movement appears to depend on nervous influence communicated by the eighth pair of nerves. When they are divided, paralysis of the muscular tunic ensues; the peristole is suspended; and the alimentary mass retrogrades into the œsophagus, and sometimes passes into the trachea, producing suffocation.

The division of the eighth pair of nerves, it has been known from the time of Galen, who first made the experiment, destroys the function of digestion. This experiment has been considered as demonstrating the intimate connexion of nervous influence with digestion, and the immediate agency of that power in the performance of this function. It may, however, be considered as doubtful, whether this operation acts otherwise than by producing paralysis of the muscular tunic of the stomach, and obliterating the sensibility of the mucous membrane. In this condition, the aliment remains immoveable in the stomach; its intermixture with the digestive fluids ceases; and the stomach being less sensible to the stimulation of the food, the secretion of those fluids is diminished or wholly suspended.

Chymification requires for its complete performance the concurrence of several acts; the absence of any of which, more or less affects this process. These are the comminution of the food by mastication or trituration, especially vegetable food; the uninterrupted renewal of the digestive fluids during the act of digestion; maceration in these fluids; a certain temperature, from 100° to 103° Fahr.; and lastly, the constant agitation and mixture of the food with the digestive fluids.

Artificial digestion, or that attempted with the digestive fluids out of the body, does not embrace these conditions. All the attempts heretofore made with this object, have been imperfect: they have not reunited the essential requisites of this process, and could not of course prove successful.

§ 2. *Chylification.*

The chyme, consisting of the nutritive and innutritive elements of the aliment chemically resolved into their separate states, but in mechanical mixture, is propelled in successive quantities, as it is formed, by the peristaltic movements, into the duodenum. In this intestine commences a second process; it has been termed a second digestion. Its object is to separate the ingredients of the chyme, and to place the nutritive elements in a condition to be introduced into the interior of the organism.

The chyme does not accumulate, and is not detained in the duodenum, as the food is in the stomach. Its movement is incessant and progressive; but the disposition of this intestine, and the distention of which it is susceptible, renders this movement slow, and subjects its contents to the action of the modifying agents placed in contact with them.

Chylification, like chymification, exhibits all the characteristics of a chemical operation. Its nature, or in what it actually consists, is not accurately known. Most of the details on this subject in books, are little more than conjectures. It is most probably effected by the action of the biliary and pancreatic fluids, but their precise operation on the chymous mass, and the changes they induce in it, are yet to be determined.

The chyme, in the superior portion of the duodenum, retains its characters; its colour, semifluid consistency, its sharp odour and acid taste are unchanged. No chyle appears in the absorbents or lacteals of this portion. But, when it has reached the openings of the pancreatic and biliary ducts, and becomes mixed with the fluids they convey into the duodenum, the chyme experiences a modification of its properties: it changes its colour to a yellow, it acquires a bitter taste, and it loses its sharp odour. Chyliferous vessels are now seen distended with chyle. When the food contains oily matters, according to Magendie, white filaments are perceived on the surface of the contents of the intestine; but other matters furnish only a grayish substance spread in a layer on the mucous tissue. Both he regards as crude chyle, or as containing the principles of the chyle. Chylification, it is thus

apparent, proceeds from the action of the pancreatic and biliary fluids on the chyme formed in the stomach.

The next step in the present inquiry would be to determine in what does this action consist. But here positive knowledge is deficient. Few facts in respect to this operation are known; and even those are not to be received with implicit credit. Most that has been, or can be written on it, is only conjecture. More numerous, prolonged, and diversified investigations, must be instituted before safe conclusions can be established as to the formation of chyle. By some physiologists it is maintained, that the pancreatic fluid and bile act no other part than that of diluents, rendering the chyme thinner, and thus enabling the lacteals to absorb the chylous portion. This is a loose conjecture. The bile is too consistent for such purpose, and a complicated fluid, with extensive apparatus, it is not presumable from general analogy, would have been provided for so simple an object, that could have been better fulfilled by the intestinal exhalation. Another, and more probable opinion, is, that this action is chemical, and its object is to cause a separation of the nutritive elements in the form of chyle, or the elements of chyle, from the innutritive matters composing the feces.

The bile, it has been already shown, is a complicate fluid, very susceptible of decomposition. Its general character is alkaline, and it possesses a strong affinity for oxygen. In the stomachical digestion acids are developed, and the aliment, it would appear, acquires oxygen, as amidon is converted in the stomach into sugar and gum. Chemists accomplish this same result by various processes, all which increase the proportion of oxygen in the amidon. In the second, or duodenal digestion, by the operation of the bile, a reverse action is effected. The acids are neutralized, and the tendency to the oxygenation of the aliment is arrested: it is, even, probable, some portion may be deoxygenated. The acids of the chyme not only combine with the alkaline salts, but precipitate the colouring principle of the bile, the picromel, cholesterine, its resin, and its mucus, which are rejected as excremental. What other changes ensue it is not easy to determine. In addition to the chemical actions between the bile and the chyme, the biliary fluid stimulates the mucous tissue of the intes-

tines, increases the secretion of the intestinal fluids, and excites the peristaltic movements of the bowels, procuring their regular evacuation.

The pancreatic liquor concurs with the bile in the production of chyle. But what is the action it creates, and the play of affinities it originates, is entirely unknown. It has been conjectured, from the azotified matters it contains, it may have some effect in imparting azote to the nutritive principles; this rests, however, on no fact.

In respect to chylification our information is exceedingly limited and imperfect. The extent of our certain knowledge is, that it is formed by the action of the biliary, pancreatic, and intestinal fluids, on the chyme. It cannot, however, be said to be absolutely formed in the small intestines, as has been supposed by many; for perfect chyle is never found in them. It is true, that, in the small intestines, the chyme separates into two parts; the one adheres to the mucous surfaces, and furnishes, or is converted into chyle in the lacteals; the other is the refuse matters that are carried into the large intestine, and ultimately are ejected from the body.

Chylous matter is absorbed by particular vessels, called lacteals, and elaborated in them into perfect chyle. These vessels are not found in the stomach, or the commencement of the duodenum. They first appear below the opening of the biliary and pancreatic ducts, are numerous in the jejunum, and disappear towards the end of the ileum. In this tract of the alimentary canal alone, can the nutritive elements of the food be introduced into the organism, or chyle be properly formed: in the other portions common absorbents only exist, and which have not the power to elaborate chyle.

Chyle is a fluid of an opaque white colour, or is opaline, and nearly transparent, according as it is formed of animal or vegetable aliment; it is thinner than milk, possesses a sweetish taste, and a spermatic odour. When drawn from a vessel it soon concretes, and shortly separates into two parts; one solid, which is formed of fibrin; another liquid and transparent, like the serum of the blood; and, when fatty matters have entered into the aliment, a third part appears, floating on the surface of the liquid,

of an opaque white colour. Chyle soon acquires, after exposure to the air, a bright rose hue. The colour of chyle is never affected by colouring substances mixed with the food.

Chyle has a strong resemblance to the blood in its general characters. When examined by the microscope, it exhibits globules similar to those of the blood. The portions into which it separates, vary in quantity according to the nature of the food. That from animal food offers the most fibrin, and when fat or oils have been used as aliment, the opaque white matter is most abundant: some vegetable substances give a chyle containing little or no fibrin.

§ 3. *Fecation.*

The chymous mass propelled along the intestinal tube by its peristaltic motion, arrives at the end of the ileum, nearly, or entirely deprived of its chylous matter. The contraction at the entrance of the ileum into the cœcum, though it does not oppose a very great obstacle, under common circumstances, to the passage of the intestinal contents, yet occasions some delay. From the numerous follicles and cryptæ located in this position, it is rendered probable, that the matters collected here are subjected to some additional operation—a further extension of digestion; and that the peculiar arrangement of the ileo-cœcal aperture is intended for this object. The frequency with which this portion of the tube is found in a diseased state, affected with inflammation and ulceration, is also an evidence of a different and more important function, than is possessed by the other portions of the ileum and jejunum.

The large intestine is the seat of fecation. The chymous mass arrives in it deprived of its chylous matters, and consisting of the detritus of the aliment, the excremental portions of the bile and intestinal fluids. While in the small intestine, these substances are semifluid, and exhibit none of the stercoraceous characters. In this state they enter the cœcum, and very soon after, the odour, colour, and appearance of the proper fecal matter, are manifested. The large intestine from its size, its dilatability, and its cellular structure, forms a reservoir capable of containing large quantities of feces; an arrangement preventing the unplea-

sant necessity of too frequent evacuations. It acts also as an excretory canal, conducting the refuse matters of digestion without the body.

The fecal matters are propelled through the large intestine by its peristaltic movements, similar to the mode by which they arrive in it from the small intestine. Their progression is, however, much slower, and, as they proceed along the course of the colon, they acquire a greater density by the disappearance of their fluid portions, either by absorption, or decomposition in the process of fecation, until arrived in the rectum, they possess a certain degree of induration, and a moulded form.

Fecation consists in the change the chymous mass experiences in the large intestine. It is a continuation of digestion, and analogous to chymification and chylification. The manner in which it is accomplished, or what are the particular actions perfecting this result, is unknown. Like the preceding operations of digestion, it must be chemical in its nature, and consist in a play of affinities between the component ingredients of the chymous mass. It is no objection to this view that the product of fecation is generally the same. The elements of the food, and of the chymous mass being similar, fecation must be uniform in its result.

Fecation is not, as might be supposed, a mere condensation of the chymous mass after it has passed into the large intestine, but is a digestive process. This is shown in the general uniformity of the feces in the same species of animals, however different the food; while, in animals of different species, with the same food, the feces are, notwithstanding, dissimilar. Every species of animal presents feces of a peculiar character.

The qualities of the food exercise some influence, however, over the general character of the fecal matters. The feces of vegetable food are less consistent than those of animal food; they are, besides, more bulky, and less thoroughly digested. The colour and odour are also modified by the aliment. This circumstance should be kept in view by practitioners of medicine, or they may be led into erroneous judgments. A gentleman of this city who had studied, but had not practised medicine, observed his stools to be black. Though in perfect health, he felt uneasy at the circumstance, as black stools are supposed indicative of great hepatic derangement. He consulted several of his profes-

sional acquaintance. One advised a course of mercury; another mercurial purgatives; and a third, travelling, or a voyage. He was fond of tomatos, of which he eat daily very freely. Knowing that the colouring matter of this vegetable readily becomes black, I assigned this as the cause of the dark appearance of his stools. A few days observation confirmed this opinion. Calomel, by its conversion into the black oxide, in the intestines, produces the same effect on the colour of the feces.

Fecation being a digestive process accomplished in the colon, and in which the fluids secreted by its mucous membrane are largely partakers, and essential to its perfection, unnatural alvine discharges are the consequences of a morbid irritation of this tissue, and the testimony of its existence. The reappearance of natural passages attests to the subsidence of the irritation, the return of the natural secretions, and the restoration of its functions.

The excretion of the feces from the intestine is accomplished by *defecation*. The fecal matters collect in the rectum, and are retained by the sphincter muscle. This muscle receives spinal nerves, and is, consequently, under the control of volition. The first contact of the feces excites no sensation, when the mucous tissue of the rectum is in a healthy state, or the fecal matters do not contain highly irritating principles. But, when the bulk of the feces collected in the rectum is considerable, a peculiar sensation is experienced. This sensation warns the intelligence of the approaching want of defecation, and solicits the acts requisite for its performance. These acts are under the government of volition: they may be refused for a limited time, that they may be adapted to the conveniences of the individual; but, when the want becomes pressing, the sensation excited in the rectum continues to advance in intensity, and so overpowering does it become as to force the performances of the acts, even in opposition to the will, by which it is to be satisfied.

When the mucous tissue of the rectum is in a state of active irritation, the sensibility to the impression of fecal matters acquires a most acute intenseness; the rectum becomes intolerant of the presence of even small quantities of feces; the sensation of a want of defecation incessantly recurs; the muscular efforts necessary for that act are excited with great force; and the sensation

itself has an energy perfectly morbid: it is this state that causes the tenesmus of dysentery.

The sensibility giving rise to the want of defecation, is most acute approaching the margin of the anus; and hence, the sensation of that want is excited in a more lively manner by liquid feces that penetrate nearer to the exterior opening, than solid feces.

The want of defecation is experienced at variable intervals depending on a variety of causes; as the power of digestion; the sensibility of the rectum, and irritability of the colon; the quantity of fecal or refuse matters furnished by the aliment; the quality of those matters being more or less irritating; and the habits of the individual.

The most common period of the renewal of this want, in adults, is once in twenty-four hours; in infants and children it is more frequent. Many exceptions exist to this rule, and in numerous individuals much longer intervals elapse, without the production of injury to their health, or any particular suffering. The inconveniences arising from costiveness are frequently owing to the condition of the digestive apparatus producing the costiveness, and of which it is a symptom, and not from the mere retention of the feces. They depend, also, in many instances, on the excess of the ingesta, while the egesta are diminished: the relation between the two not being preserved. Whenever unusual slowness of the bowels prevails, it is to be regarded as an evidence of some defect in the digestive organs or processes, which should be investigated and remedied. The best method of attaining this purpose, is by the regulation of the food, both as to quantity and quality. Artificial excitement of the bowels by purgatives, especially of the more active purgatives, should be cautiously avoided. They become accustomed to that mode of stimulation, and will not act in a natural manner. The evil, like that of intemperance in the use of ardent liquors, perpetuates itself. Persons who are in the frequent habit of taking purgative medicines to obviate costiveness, rarely enjoy health, and, according to my observation, are seldom long-lived.

While the fecal matters awaken the sensation, that has been described, in the rectum, announcing the want of defecation, and

soliciting the voluntary efforts to effectuate this purpose, they excite immediately the contractions of its muscles. When the fecal matters are liquid, these are adequate to their expulsion; but, when they are consistent, additional power is required. Defecation is, then, accomplished by the involuntary contractions of the muscular layers surrounding the rectum, and of the action of muscles directed by volition: these are, principally, the muscles of expiration. The glottis being closed after a full inspiration, and the escape of the air from the lungs being, thus, prevented, the force of the expiratory effort is expended on the abdominal viscera. They are compressed on every side, and pressed down by the diaphragm towards the pelvis, where the least resistance is experienced. The diaphragm, and the levatores ani and muscles of the perineum forming in part the base of the trunk, antagonize each other. The fecal matters urged forward by the peristaltic motion, and by the muscles of the rectum, compressed from above, and resisted below, are forced against the sphincter. This, partially relaxed by the will, offers only a feeble resistance, and, yielding to the combined expulsive efforts, the feces are discharged. When consistent, they are moulded to the form of the lower part of the rectum, and by their shape, we are frequently enabled to determine, whether the caliber of the rectum be of natural capacity, or is contracted by thickening or stricture.

The contractions of the expiratory muscles, for the purposes of defecation, are, in general, regulated by the will; and this act is, in a certain extent, under the control of volition, when the want is experienced in a moderate degree. But when that sensation is very intense, as in tenesmus, although little or no fecal matters be present in the intestine, the expulsive efforts of the voluntary muscles are constantly and irresistibly commanded, and cannot be prevented by the exercise of volition. This phenomenon is singular, and well worthy of attention. A sensation at the extremity of the rectum throws into action numerous muscles—those of the glottis, of the thorax, the diaphragm, the abdominal and pelvic muscles—all of which are united in synergistic efforts. This action of the muscles is, independent of the power of volition, as it is not commanded by the will, and often resists the most determined efforts to repress it. It must, then, proceed from the sympathetic or ganglionic nerve, which is here seen, as in

respiration, to command actions called for by the internal sensations, and to combine different organs in consentaneous actions.

The sensibility of the verge of the anus loses in some instances its vivacity; fecal matters collect without exciting a sense of a want of defecation, the rectum becomes distended and impacted with them; its muscles from being overstretched are paralyzed, as it were, and cannot contract on the contents of the bowel; and no efforts are adequate to expel the indurated mass collected within it. This state occasions great distress, with extensive disturbance in the economy, and yet will be misunderstood unless detected by a positive examination. Mechanical means are often required to dislodge the hardened feces blocking up the lower intestine.

Gases in greater or less quantity exist in the alimentary canal. They are oxygen, carbonic acid, hydrogen, azote, carburetted and sulphuretted hydrogen. They do not equally exist in every part of the intestinal tube, or in the same proportions. In the stomach oxygen is always present, and very little hydrogen; in the small intestine no oxygen is found, and considerable quantity of hydrogen; and in the large intestine, carbonic acid, carburetted and sulphuretted hydrogen predominate.

The origin of these gases is not absolutely determined. Some proceed, doubtless, from the air swallowed intermixed with the food; the chemical actions in which digestion consists, gives rise, it is very probable, to others; and, it is equally probable, no inconsiderable portion is a product of secretion from the mucous membrane.

The quantity of these gases is very variable. In some individuals it is inconsiderable; in others they abound in large quantities, and become excessively annoying. The irritations of the mucous membrane of a chronic or sub-acute character, often develope them to an enormous amount. I have seen patients in this state discharge several gallons of air from the stomach daily for months in succession. In hysteria, so often depending on chronic irritations of the alimentary canal, the secretion of gases from the intestinal mucous membrane is an almost constant occurrence. The last stage of gastro-enteritic irritations exhibit the same circumstance, whence proceeds the tympanitic state of the abdomen.

SECT. IV.—*Stomachical Excretions; or Eructation, Regurgitation, and Vomiting.*

In a perfectly healthy state of the stomach, its contents take the course described in treating of digestion. But often in the interruption of this process, instead of passing into the intestinal tube, the gaseous, liquid, or solid matters contained in that organ, are rejected by the mouth. The acts effecting this result are named eructation, regurgitation, and vomiting.

The air contained in the stomach collects, from the position of this viscus, around the cardiac orifice; it is hence frequently expelled by what is termed eructation, or belching. This is effected by the relaxation of the cardiac orifice, and the inversion of the muscular movements of deglutition. Eructation is a constant symptom of indigestion; and especially when proceeding from irritation of the stomach.

The solid or liquid aliments are, at times, returned back to the mouth, and often in this way are rejected. This act constitutes regurgitation. It most commonly arises from over-distention of the stomach. In infants it is a constant occurrence, and is the mode by which they are relieved from the excessive repletion of their stomachs.

This act is caused sometimes by the contraction of the abdominal muscles; but most probably is effected by the immediate contractions of the stomach itself. The food is, thus, carried into the œsophagus, by the inverted movements of which, it is propelled into the mouth.

This phenomenon is usually involuntary, yet some can produce it at will; and instances are related of individuals who took pleasure in returning the aliment into the mouth, and masticating it. In this respect they resembled completely the ruminant animals. Regurgitation is a frequent attendant on the disordered state of digestion, when proceeding from excesses in eating.

The stomach is the great portal conducting into the interior of the organism, through which nearly all the solid and liquid materials of the structure are conveyed into the animal economy. From its office it is greatly exposed to numberless aggressive impressions, either from the quality or the quantity of the ingesta;

and for its protection, it was essential, means for its prompt evacuation should be provided, that it might be disembarrassed of its load when oppressed, or be saved from the direct mischief of offending agents. For this purpose the process of vomiting has been instituted, accomplishing the evacuation of the contents of the stomach through the mouth.

This act, like all the expulsive operations of the economy, requiring muscular contractions, is preceded and provoked by an internal sensation. This sensation is peculiar—it cannot be defined; and, similar to the other internal sensations, announces a want; calls upon, and directs the sensorial power to the operations requisite for its relief. The term *nausea* is bestowed on this sensation: it is seated in the stomach, to which organ it is always referred, but the whole of the superior portion of the alimentary canal—the œsophagus, pharynx, fauces, and mouth—appear to partake of it in some degree. It is well known, also, that irritations excited in the fauces are capable of occasioning vomiting.

Vomiting is provoked by numerous causes of very dissimilar nature. It is caused by excess in the quantity of food; by indigestible food; by aliment of improper quality, or which undergoes spontaneous alteration in the stomach from the suspension of digestion; by certain substances excitative of irritation in the mucous membrane of the stomach, and which are employed as vomitive agents; by pathological irritations spontaneously deve-veloped in the gastric mucous tissue, or sympathetically transmitted to it; and by mental or moral impressions.

The essential circumstance in the production of vomiting, is an irritation awakened in the gastric mucous membrane, attended, most commonly, with the peculiar sensation of nausea, and its transmission to, and perception by the brain. Vomiting, requiring the concurrent operation of voluntary muscles, cannot be effected without nervous influence directed to produce their contraction; and hence the perception or consciousness of the gastric irritation is indispensable to the performance of this process. Whenever, therefore, the perceptive power of the cerebral organs is enfeebled or suspended by disease, vomiting cannot be produced, although violent irritation may exist, or be provoked artificially in the stomach.

Whenever nausea and vomiting are present, they are a sign, a

testimony of an irritation, either commencing, or established in the gastric mucous tissue. It does not necessarily follow, as is generally supposed, that offending matters in the stomach are the cause of those symptoms. Such matters are in the great majority of instances speedily ejected; they assume the character of emetics, and cause their own rejection. Nausea and vomiting are not, consequently, to be received as indications for the exhibition of emetic remedies. A more false axiom could not have been formed. They are an indication that an irritation exists in the stomach, which requires to be allayed by inirritative means.

In exciting vomiting by emetic remedies, the feature of chief importance in its modus operandi, and which should principally occupy the reflection of the practitioner in deciding on the propriety of employing it, is the irritation it must necessarily occasion in the stomach. It must, then, enter into the combinations he has to form, to determine the relation this irritation will sustain with the actual condition of the gastric mucous tissue; the compatibility of the one with the other; and the manner in which the modification he is about to effect in the gastric mucous tissue by this emetic irritant, is to remove a morbid irritation of this same tissue; or the mode in which it is to prove salutary. Without a decision on these points, his proceeding will be uncertain, and often hazardous in its results. The production of aggravated gastritis, of convulsions, of stupor, of coma, and of apoplexy, may be the unlooked-for consequences of his prescription.

The mechanism productive of vomiting is complex, and has not yet been cleared of all the difficulties attending its explanation. For a long period it was generally conceded, that vomiting was effected solely by the stomach, which expelled its contents by a violent and spasmodic contraction. Bayle first questioned the accuracy of this doctrine, which was also attacked by Chirac. Still it continued to be the most generally received opinion, and although every one was conscious that vomiting was attended with excessively violent contractions of the abdominal muscles, this circumstance was overlooked, or regarded merely as an attendant accident, unconnected with the production of the phenomenon.

M. Magendie, in a memoir on vomiting, contested the accuracy of this opinion, and attempted, by a series of experiments,

to demonstrate, that the stomach was entirely passive in vomiting: he denied the slightest participation to it in this act. His observations are, however, in some degree invalidated by those of M. Maingault. M. Magendie, it is not to be doubted, is quite too exclusive in his views in this respect. The stomach, by the inversion of its peristaltic movement, and that of the œsophagus, can reject, at least partially, its contents, as is seen in the phenomenon of regurgitation; but this simple return of the aliment into the mouth, and its rejection in this mode, accomplished by the sole expulsive efforts of the stomach, presents very different characters from vomiting.

The object of vomiting being to expel from the stomach the whole of its contents, especially in the view of protecting it against offending causes, that often are small in quantity, and adherent to its parietes, a more powerful expulsive force was required, than could be offered by the delicate muscular tunic of the stomach. This force is derived from the diaphragm and the large muscles of the abdomen, which, when thrown simultaneously into contraction, subject the stomach to a very energetic compression. This co-operating with the efforts of the stomach, and the inversion of its peristaltic motion, the contents of that organ are forcibly expelled from its cavity through the mouth.

Vomiting under common circumstances is not, therefore, a simple process; it is a complex phenomenon, and its performance requires a combination of different actions. Like defecation and urination, vomiting is in part effected by the forcible contraction of voluntary muscles; but it differs from this last act in never being influenced by the will: it can neither be promoted nor arrested by volition. In vomiting is presented another instance of voluntary muscles subtracted, for a time, from the dominion of volition, and subjected to the influence of the viscera, whose sensations compel the muscular actions calculated in their interests.

From the foregoing considerations we may conclude, as established, that, for the production of vomiting the following circumstances are usually combined:—1st, an irritation of the mucous tissue of the stomach or fauces; 2d, inversion of the peristaltic movements of the stomach and œsophagus; 3d, the excitation of the nervous organs directing muscular contractions; and 4th, convulsive or spasmodic contractions of the diaphragm and abdominal muscles.

Vomiting being accomplished by the convulsive and forcible contractions of the diaphragm and abdominal muscles, the stomach is not the only organ that experiences their power. All the abdominal viscera, the portal circulation, and the thoracic organs, are equally exposed to suffer their violent throes; they equally undergo a strong agitation, and are subjected to extreme disturbance in their functional and organic actions.

When the stomach is distended with its contents, and especially when those contents are liquid, vomiting is effected with facility, and very slight contractile exertions are required for that purpose. But when the stomach is empty, or its contents are small in quantity, the muscular efforts are much greater, the convulsive throes are more violent, and vomiting is produced with difficulty and much suffering.

The inversion of the peristaltic movements of the stomach in vomiting, extends generally into the duodenum, and some of its contents appear with the matters ejected. This is the source of the bilious materials that present themselves in vomiting. The inversion in some instances extends far into the alimentary canal, and, then, the contents of the lower bowels are brought up, producing stercoraceous vomitings.

In the artificial production of vomiting, the impression made on the gastric mucous tissue is the principal circumstance which should command the attention of the practitioner. When vomiting occurs as a pathological condition, it is likewise the state of this same tissue to which the attention should be directed. Vomiting in disease, in the greater number of instances, is an effect proceeding from irritation developed, either directly, or through sympathy, in the gastric mucous membrane. It is one of the signs of this morbid condition. No greater error is committed than that of regarding vomiting, from this cause, as a consequence of some vitiated matters requiring to be removed. Under this impression emetics are administered; but their mode of action is in the line of the disease; they push on the morbid irritation, give it new intensity, develope or augment the sympathetic phenomena, especially of the brain, and are succeeded, often, by symptoms of great malignancy, too commonly attributed by superficial observers to the nature of the original affection, and not to the medicine. Infinite

is the mischief that has been caused by the improper exhibition of emetics, and, although diminished by a more restrained employment of these means, it is unhappily still too great. Vomiting is not, then, a sign indicating the exhibition of emetics, with some few exceptions, but is an evidence of an existing irritation of the stomach, usually sanguine, and calling for demulcents, temperants, and other soothing means, with local or general depletion, according to circumstances.

Vomiting is sometimes produced by simple nervous irritation, or some disorder of the nervous organs, excitative of the muscular contractions, causing vomiting. It is probable that vomiting is excited in this way, by some kinds of motion, as sailing in rough water, swinging, and riding backwards; by the sight of disgusting objects; by blows on the head; by venesection carried to fainting; and by tartar emetic injected into the veins. The extirpation of the stomach, as in the experiment of Magendie, does not, in this last case, prevent the operation of the emetic.

Nervous vomitings are, however, of rare occurrence as a pathological condition, and may be discriminated by the absence of all the signs of sanguine irritation.

Sect. V.—*Hunger and Thirst.*

The materials of the animal structure are exhausted by the exercise of its organic and functional actions. They require an instauration: a knowledge of its necessity is not left dependant on the intelligence, but is announced by internal sensations: these sensations are seated in the digestive apparatus: that which proclaims the want of the solid materials is experienced in the stomach, and is appetite, or hunger; that which manifests the necessity of liquids is felt in the fauces, and constitutes thirst.

1. Some hours after a meal a sense of emptiness is perceived in the stomach; this is succeeded by a peculiar sensation impossible to describe, but well known by the name of appetite. If not gratified, it continues to increase, becomes painful, and, should the fasting be prolonged, amounts to a state of inexpressible agony.

The renewal of the sensation of hunger is experienced at dif-

ferent intervals. They are more approximated, according to the rapidity and energy of the digestive faculties; to the youth and vigour of the subject; and to the exercises of the body. It often commences before the whole of the preceding meal has disappeared from the stomach.

The seat of hunger appears to be the gastric mucous membrane. The immediate excitant of this sensation, or the mode of its development has given rise to numerous conjectures; but none of them merit a serious attention. The utmost that can be said of it, is, that it consists in a modification experienced in this tissue.

This sensation, like all other sensations, requires to be transmitted to the brain, and from analogy, it is to be presumed, an especial nervous organ for its perception. The nerves transmitting the impression of hunger, are the cords of the eighth pair, for, if these be divided, animals cease to manifest a sense of hunger. They equally lose the perception of repletion, and will continue to eat until the stomach be gorged, and even the œsophagus be distended with food. The sensation of hunger depends also on the perception, by the central cerebral organ, of the famelic stimulation of the gastric mucous membrane, and whenever the functions of the cerebral organs are diminished or suspended, hunger is not experienced. Thus, opium, by the torpor it induces in the cerebral organs, prevents the famelic stimulations from being perceived, and it, consequently, suspends the sensation of hunger. Hunger is also suspended by sleep, and, when not very intense, by mental occupation, which attracts the cerebral energy to other organs.

The external sensations are caused by the direct impressions of exterior agents on a sensitive surface. This is not the case with the internal sensations, especially of hunger and thirst. There is no immediate or direct impressions on the surfaces where these sensations are experienced. How then are they excited? Various hypotheses have been imagined for the solution of this curious phenomenon, none of which are, however, worthy of serious notice. It must be confessed, that on this point, we have not the facts to justify any doctrine.

The sensation of hunger is a powerful stimulus to the brain. It excites that structure; it fixes on the want the whole attention of the intellectual and moral faculties; it stimulates and renders them

more active: all the capabilities with which the being is endowed are called into exertion. Hence proceeds the great muscular activity and energy of animals and healthy individuals who are pressed with hunger; the impatience with which any interruption to their pursuit or train of thought at that time is borne; and the ferocity manifested by all who have combative dispositions. The debility produced by hunger, occurs only secondarily, after long starvation, or in individuals enfeebled by previous sufferings, or having originally a defective constitution.

Hunger, when carried to extremity, causes pain of an agonizing character; irritation of the stomach is excited; and a true gastritis is generated. This state is frequently accompanied with cerebral irritation, producing delirium, frenzy, and madness.

The sensation of hunger is sometimes experienced as a pathological symptom: it constitutes *bulimia*, and depends on various causes. In this affection the sensation of hunger is not appeased by the taking of food. It is occasionally connected with a certain state of irritation, and, then, the food is generally vomited soon after it is taken: it is also accompanied in many instances with convulsions. Bulimia may exist as a neurose affection—that is, depending on simple nervous irritation. The seat of this sensation may possibly be, at times, in the cerebral organs, giving rise to a false perception of hunger, as false perceptions of the external senses arise from excitement of their central cerebral organs.

The appetite and sense of hunger are frequently lost, and even an unconquerable aversion is experienced for food, especially for animal food. This symptom is found in all the acute irritations of the gastric mucous membrane, and frequently in its chronic irritations. In some cases of this kind, I have found the mucous membrane of the stomach softened and wasted, so as to be scarcely discernible.

When abstinence from food has been protracted to a state of starvation, aliment is to be given with the utmost prudence and delicate management. It is well known, that indulgence of the appetite is, then, attended with speedily fatal consequences. The gastritis developed by starving, and its attending sympathetic affections, more particularly those of the cerebral organs, are the cause of this result. The stimulation of the aliment aggravates the existing inflammations, and carries them to a fatal intensity.

After complete and prolonged abstinence, food is to be administered in small quantities, and the quality should be adapted to the intense inflammations that have been awakened; such as milk diluted with water; whey; chicken or veal water; panada; gruel, &c. It may even be requisite to employ local depletion.

2. *Thirst*, or the desire of liquids, is a sensation of dryness, heat, and constriction experienced in the fauces.

This sensation, like that of hunger, is instinctive; nor does it depend, like the external sensations, on any direct impressions, but is a consequence of spontaneous modifications occurring in the organs of the economy.

Thirst, it is to be presumed, bears a close analogy to hunger in its mode of production, though it cannot be as well demonstrated: that is, it requires nervous agency—organs for its perception in the brain, and nerves for transmission, with a certain modification of the mucous tissue of the fauces, its immediate seat.

When thirst is experienced, the secretion of the mucous follicles of the mouth, fauces, aud pharynx, is diminished, or entirely ceases; the secretion of the saliva is lessened, it is more viscid, and finally is arrested. In thirst, aridness of these surfaces always exists, and is probably the immediate cause of the sensation. Hence it is temporarily allayed by whatever lubricates and moistens these surfaces or excites their secretions.

When thirst persists unassuaged by drinks, the mucous membrane of the fauces and mouth, &c. like that of the stomach in hunger, inflames; it becomes tumid; it acquires a deep red colour, passing, when it continues, to a brown, and finally black; it is covered over with fissures; is sometimes encrusted with vitiated secretions or a sanguine exudation; and occasionally is struck with gangrene.

Thirst unabated always developes symptoms of general irritation; fever is excited with sympathetic irritations of the nervous organs, and disorder in all the functions of the economy. These phenomena are indicative of intense irritative actions, and renders it probable, that the sensation of thirst depends on a species of irritation developed in the mucous membrane of the mouth, fauces, and pharynx.

Thirst proceeds from two exciting causes. The first is an irritation awakened in the stomach, sympathetically affecting the

fauces. Stimulating food, a full meal, inflammation of the stomach, whatever excites that organ, produces thirst. This sensation is one of the attending symptoms of gastric irritation, both acute and chronic.

The second is the deficiency of the watery portion of the blood. The exhaustion of the more liquid portion of the blood always gives rise to thirst. From this cause thirst recurs at intervals after drinks have been taken; it is induced by profuse sweating; by the exhalation of the serum into the cavities in dropsy; by its abundant evacuation in diabetes and in diarrhœa, when the stools are liquid, &c. Thirst from this cause is allayed by the injection of watery fluids into the veins; by immersing the body in water, or covering it with wetted cloths, &c. as readily as by drinks.

A sensation of thirst is experienced by those who abuse the use of ardent spirits; most probably produced by the irritation maintained in the stomach. This circumstance occasions them to renew their pernicious draughts incessantly, but which only increase the evil, augment the desire for drinks, rendering it unappeasable, until lost, with the entire suspension of all the sensations in brutal insensibility. This constitutes one of the difficulties in the cure of intemperance.

Thirst is experienced by children more frequently and constantly, than by adults and the aged; and by those of the nervous and sanguine temperaments, than by those of the lymphatic. Infants frequently suffer great distress from thirst, without parents or nurses being aware of the circumstance. I have seen convulsions brought on from the agony of thirst, endured by infants, without a suspicion being entertained of their suffering from this cause. It is a frequent source of the distress they manifest in teething, and in the other irritative affections, especially of the stomach, to which they are so very subject. It is this sensation that leads them to apply incessantly to the nipple for relief; but the milk from its temperature, and the excitement it occasions by the necessity of its digestion, fails to assuage the torment they experience: restlessness, sleepless nights, unceasing cries, spasms, convulsions, are not unusual effects of the ardent sufferings endured by infants from thirst, but which they have not the power to express in language. Repeatedly have I witnessed them passing speedily from the most distressing fretfulness and ungovern-

able agitation, to calmness, repose, and tranquillity, by administering a few draughts of a cooling beverage. Whenever infants manifest this state, with febrile symptoms, and a furred tongue, they should invariably be made to take cool and sweetened drinks, or sweetened water slightly acidulated.

Thirst is a symptom attending on numerous forms of disease, and has always attracted the attention of semiologists: it furnishes valuable indications in diagnosis, in prognosis, and serves as a guide in practice.

Thirst, as a diagnostic sign, is an indication of two different conditions of the economy, corresponding to the causes that give it origin. It is awakened by whatever causes excitement of the mucous tissue of the stomach: it always accompanies gastric irritation in its acute form, and is a frequent attendant on its chronic state. Thirst, from this cause, points to the stomach as the seat, not of the sensation, for that is never experienced except in the fauces, but of the primary action calling it into existence; it persists until that action is abated.

The second condition announced by thirst is, the diminution of the serous or watery portion of the blood. This state may exist cotemporaneously with gastric irritation, but may be entirely independent of it, and result from excessive serous or watery excretions of various kinds.

Extreme thirst, indomitable by copious draughts of liquids, is named *polydypsia.* It has been considered in some instances to be an essential disease; but is to be regarded in all cases only as a symptom of one of the conditions indicated. It is always an unfavourable symptom; and in acute diseases, when other symptoms do not correspond in their character, is always a fatal omen.

In some individuals thirst is never experienced; some animals also never manifest this want; and it occurs occasionally as a pathological character. The defect of this sensation is named *adypsia.* This is an uncommon circumstance in disease. It occurs in some chronic affections, and is found occasionally in the malignant form of fevers; assuming the typhoid character. It arises from the intensity of the cerebral disease preventing the perception of the sensation: it is consequently an unfavourable sign. When it succeeds suddenly to extreme thirst in fever, it is a fatal symptom.

SECT. VI.—*Pathological Conditions of the Function of Digestion.*

The foregoing review of the apparatus and function of digestion, composed of a variety of different organs and a combination of different processes, renders very apparent, that this function is exposed to numerous derangements, and may become disordered through a great variety of causes. Indigestion or dyspepsia, and the other disorders of the digestive functions are not to be looked on as simple and uniform diseases, proceeding from one cause, and to be remedied by one plan of treatment. Dyspepsia is a symptom, in the greater portion of instances in which it occurs, rather than a disease itself, and is an annunciation of a departure in some part of the apparatus, from its habitual condition, or a defect in the execution of some one of the processes whose reunion are essential for the accomplishment of digestion.

The disorders of the function of digestion, affect either the process of chymification or of chylification; or both are equally deranged at the same time.

The causes creating disturbance in the order of these processes are various. I. *Chymification* may be deranged; 1, by the food; which may offend by its quality, or the quantity taken. When the aliment consists of substances containing few or none of the nutritive elements, it resists the decomposing actions of the stomach, or yields to them with difficulty: it then becomes a source of irritation to the stomach, and modifies its physiological state, producing more or less of disturbance in its actions. Whenever the food is not in relation with the vital condition of the stomach —that is, its stimulant or irritating properties are not proportioned to the irritability of the mucous membrane of the stomach, it causes a morbid disturbance of a similar character to the preceding; the process of chymification is then retarded, or suspended, and the food is frequently rejected. Thus, when the stomach is irritated, the only aliment that can be digested, is vegetable fecula, farinaceous substances, and similar matters of a bland unirritating nature; while animal food, and other substances of irritating properties and difficult digestion, occasion great distress,

oppression, a febrile condition, or are rejected by vomiting. Food that is not properly cooked, whose consistency is augmented, as salted and smoked or dried meats; or food that is not comminuted by mastication, but bolted in masses, by resisting the decomposing process, fatigue the stomach, and when it is irritable, stimulate it to a morbid excess, thus interrupting digestion.

The food, though it may possess the required properties of healthy aliment, and bear a just proportion in its qualities to the state of the stomach, if the quantity be excessive, will occasion serious disturbance in digestion. From the history we have detailed of the process of chymification, it is clearly seen, that the decomposing process in which it consists, is accomplished by particular fluids. The supply of these is limited, and if the food exceed that supply, digestion must be laboured, be performed with difficulty, and in an imperfect manner.

When the imperfection of the digestive function proceeds from too great irritability of the gastric mucous tissue, as it so frequently does, the prolongation of this function carries the morbid state to a degree entirely suspending or subverting its function. Digestion will, then, be easily performed with small quantities of appropriate food, whilst a very small amount beyond that, will throw the whole process into confusion. Nothing can be more injudicious than the advice, so frequently laid down by writers, in the treatment of impaired digestion, to take but few meals, and those rather full. It is far preferable to divide the whole quantity of food allowed in the twenty-four hours, into several small meals; the stomach will digest it with less difficulty and suffer less excitement. But care must be taken to limit the quantity of food; for such is the perverseness of most patients, that they will take at each meal, as much as would suffice for the day.

2. Chymification may be imperfectly performed from a morbid or defective condition of the masticatory apparatus. Inflammation of the mouth, affecting the gums, the tonsils, &c. will have this effect. Decayed teeth, or their loss, are a common cause of indigestion. The proper comminution and insalivation of the food, so essential to easy and perfect digestion, are prevented. Few persons with a bad mouth digest well, and it is often sufficient to repair the state of the teeth, and to remove those that are decayed, to restore digestion to its natural order. Defective teeth, by

maintaining a constant irritation of the mouth, often cause the salivary secretion to assume a vitiated character, or diminish its amount, and in this way interfere with healthy digestion.

3. Chymification may be prevented, or the actions requisite for its performance be deranged, by a morbid state of the gastric apparatus. The most common is the irritation of the gastric mucous membrane. This state always disorders its secretions; by the strict sympathetic connexions in which it holds the other functions of the digestive apparatus, all the secretions employed in the digestive process, are more or less affected, and the function necessarily rendered imperfect. From this irritation acids are frequently formed in great excess, and they appear to interrupt the process of chymification; for it suffices, often, to neutralize them by alkalies, for this process to proceed uninterruptedly. At other times, the quantity of the fluids usually secreted, appear to be diminished; heat is experienced in the epigastrium; thirst, dryness of the tongue and fauces, with flushing of the face, febrile heat of the skin, &c. are established. The constant sipping of cold drinks, even of iced water, by restraining the gastric excitement, represses or prevents these effects, and chymification is then accomplished with facility. At other times this irritation is productive of profuse secretions of sero-mucous fluid, which is not adapted to digestion, and the function deteriorates. Nausea and vomiting after eating is also a common result of gastric irritation. In indigestion arising from irritation, animal food, tonics and stimulants of all kinds, prove injurious; they augment the cause of the affection; increase the intensity of the functional derangement; and perpetuate the disease by connecting it with structural disorder.

All the acute sanguine irritations of the gastric mucous tissue, are attended with loss of appetite, and impairment of the digestive faculty of the stomach. The history of these, and the disorders they spread throughout the animal economy, belong to pathology, where they will receive attention.

Simple nervous irritation, seated in the gastric mucous tissue, free of complication with sanguine irritation, does not materially disturb the process of chymification. Hence many persons who suffer severely from gastralgic pains, nevertheless digest well, and suffer no alteration in their nutrition.

4. Excessive distention of the stomach from the extrication of gases in its cavity; the relaxation of the fibres of its muscular tunic, or their paralysis, by preventing the peristole of the stomach, and thereby the regular commixture of the food with the gastric fluids, and its due progression towards and through the pylorus, as chyme is elaborated, are causes destructive of the proper chymification of the aliment.

5. Chymification or gastric digestion is, in some instances, subject to be disordered by a state of inirritation, or asthenic condition of the gastric mucous tissue. This, which is by no means a common cause of indigestion, is, notwithstanding, supposed to be one of the most frequent: and the vulgar treatment of dyspepsia, rolls in a round of tonic, exciting, and stimulant remedies of various kinds. The error arises from confounding debility, loss, or derangement of function, with the actual debility or diminution of the organic actions. The first—disturbance or loss of function, is a uniform consequence of excess of the organic actions, irritation or morbid excitement, and the mistake alluded to is fraught with most disastrous results to the patient.

This state of the gastric mucous tissue is seldom primitive: it is almost uniformly secondary in its origin, succeeding to irritative actions, either of the mucous membrane of the stomach itself, that have modified its mode of nutrition, or of other organs, that have indirectly diminished the force of its organic actions.

Defective chymification, or indigestion, as it is usually called, from this cause, is aggravated by mucilages, gelatinous, and other aliment destitute of exciting properties. It is relieved by tonics, by stimulants, and by food of exciting character; the means that augment its disorders, when proceeding of irritation of the gastric mucous tissues.

II. *Chylification* is seldom deranged alone; its disorders usually accompany those of chymification; but they may sometimes persist after the subsidence of this last: in some rare instances, this function is primitively and separately affected.

The derangements of chylification arise from causes analogous to those productive of disorder in the preceding process, and which have already been indicated.

1. Irritation of the duodenal mucous membrane is the most common source affecting its functional duties. The results of this

irritation are various: it renders the intestinal surface intolerant of the presence of the chymous mass arriving from the stomach, which is, consequently, hurried rapidly along, preventing the due action of the biliary and pancreatic fluids: it sometimes excites violent spasms, and may be mistaken for gall-stone passing the ductus communis: and increasing its sensibility and irritability the performance of its functional acts is attended with pain, uneasiness, distress, and often sympathetic irritative disturbances in other organs. It is this pain, experienced in the duodenum, and referred to the right hypochondriac region by the patient, that has led so frequently to an accusation of the liver in the various forms of duodenitis: it is constantly mistaken for hepatic disease.

2. Defective quantity or quality of the biliary and pancreatic fluids, the agents of the duodenal digestion, will necessarily affect this process. Ignorant as we are of the actions exercised by these fluids on the chymous mass, it is not possible to determine, with precision, the absolute character of the disorders depending on these fluids. It will, however, be admitted as indisputable, that the vitiation of these fluids by a morbid secretion, or their deficiency, must necessarily render the process of chylification imperfect. The influence of the bile in causing disorders of the digestive functions has been recognised at all periods, and continues to be the popular explication of nearly all the symptoms arising from sur-excitations, or other disorders of the digestive organs.

The alterations these fluids undergo are the consequences of a morbid state of their respective organs; most commonly their surexcitement, or irritation; or the effects ensuing on a continuance of that condition. But, as has already been expressed, it is seldom the affection of these organs is primitive; it most generally succeeds to duodenitis; and it is, further, infinitely more rare than is vulgarly believed to be. A very small portion of the cases of irregular digestion, attributed to hepatic derangement, are connected with that cause. Autopsical researches have repeatedly confirmed to me this assertion.

The bile, from too great excitement of the liver, may prove an offending agent, by its too great quantity; and from having acquired acrid properties, as is seen in other secretions under the same circumstances: hence will proceed bilious vomitings and dejections.

It may, also, in the chronic irritations of the liver, be so altered in its nature as to be disqualified for the purposes of digestion, which will derange that function: and when that organ has experienced alteration of its structure, bile may cease to be secreted. In some of the extreme acute irritations, as violent cholera morbus, and some cases of jaundice, no bile is secreted, and does not appear in the excretions.

III. The intestinal digestion is subject to disturbance, but of which our knowledge is imperfect. The most common cause is irritation of various intensity of the mucous tissue of the intestines. This state occasions vitiated secretions and exhalations, appearing in the dejections, and which are too commonly mistaken for evidences of hepatic disorder. It sometimes occasions so great an irritability of the muscular tunic, that the contact of the digested matters excites its contraction, and they are rapidly expelled from the alimentary tube. The whole digestive process becomes disturbed from this state of the intestines. The food is not permitted to remain a sufficient time in the stomach and duodenum, for the perfection of their respective actions, but is carried into the lower bowels and eliminated. In higher grades the food passes with great rapidity, and is dejected without having experienced any change. This constitutes *lientery.*

When the large bowels are in this irritated state, they lose their character of a reservoir, and intolerant of the presence of fecal matters, these are expelled as fast as they arrive within it.

A grade of irritation affecting the mucous follicles, and suspending their secretion, is attended with an opposite condition, or torpor and slowness of the bowels. It is not uncommon to suppose this state to arise from a deficiency of bile, and purgatives, with mercurial preparations, are exhibited; but which frequently confirm the disease, though producing temporary relief by the evacuations they procure. The English writers generally attribute it to debility of the muscular coat, and prescribe tonics with purgatives. It is, however, obviated most successfully by a cooling and laxative diet.

The derangements of the digestive functions are among the most important affections calling for the remedial management of the medical practitioner. The organs executing these functions, by the close and active sympathies uniting them to the most im-

portant of our organs, may be said to hold the whole animal economy under their dominion, while the mode of being of every tissue, and exercise of every other function, are dependent on the condition of their performance. The preceding view of these functions and their organs, will show the complexity attending their diseases; the great discrimination required in determining their character, and the organ of the apparatus in which the difficulty is seated, giving rise to the interruption of the process; the skill and judgment necessary in their treatment; and the variety of practice and abundance of resources on the part of the attendant, indispensable to secure a successful issue.

CHAPTER II.

Function of Absorption.

The existence of organized beings is made to depend on supplies of nutritive materials derived externally, and the incessant renewal of the elements of their composition. Those supplies must, consequently, be introduced into the interior of the organism; and the elements that have subserved the purposes of vitality be removed for their exterior elimination. A centripetal, and a centrifugal action are, thus, unceasingly maintained. The condition above stated necessitates a function for its fulfilment; and this function, absorption, now presents itself in the order of investigation, that its relation to the physiological and pathological state may be determined.

Absorption it is seen accomplishes different objects: it might, then, be inferred, a priori, that it is not a simple, single, and uniform process.

In the simpler animals of the lowest classes, whose structure is a single tissue of homogeneous nature, consisting of a single element; neither vessels, organs, or apparatus, for the execution of functions exist. The molecular elements of their structure, being every where the same, maintain, with each other, and with exterior matters, the same relations. Each part possesses within it-

self the conditions of its existence independent of any other. Aggregation and a determinate form, are the sole requisites of the animal organization.

Placed in the media containing the elements of their being, each molecule attracts, or takes up, in a direct manner, and by its inherent powers, the supply necessary for animal existence. In such beings organs and functions are dispensed with: and absorption is a property of the molecular structure, effected by a molecular action. But a structure similar to that of the simpler, exists in the more perfect classes of animals; it constitutes the basis, or first element of their organization, forming the web, as it were, of the organs: this molecular absorption, consequently, exists in them.

In the more complex organizations, composed of different elements and organs, and whose various portions possess relations with each other, and with external agents wholly dissimilar, simple molecular absorption could not alone fulfil the various necessities of the being. Functions are, then, present, executed by an apparatus; and, for absorption, an especial structure, or set of organs, is superadded to the molecular absorption, without this last being superseded.

In the human organization absorption is not, then, always an identical process. It partakes equally in the composition of the body, by conveying into it the materials of its structure; and in its decomposition, by taking up, for external elimination, the elements rendered effete and exhausted by vital processes. It may appropriately, therefore, be divided into external and internal absorption. The first is of two-fold character: first, as introducing into the economy, from the intestinal canal, the nutritive elements prepared by digestion; and 2d, as taking up exterior matters unchanged in their nature and properties.

Internal absorption is likewise of two kinds: the absorption of lymph, or white fluids, performed by lymphatics; and of blood, or coloured fluids, executed by veins. In both these classes of absorption free or disengaged molecules on the surfaces of the tissues, or in the intimate texture of the organs, are seized on, and conveyed into the sanguine apparatus, the common receptacle of the principles destined for nutrition, and for elimination. The movement of the absorbing system is concentric or centri-

petal—that of the sanguine is eccentric or centrifugal. The two systems are not in direct communication: at one extremity the heart is interposed between them; at the other, intermediate to the arteries, the veins and lymphatics, are the capillaries and the areolar, interstitial meshes, or spaces of the ultimate molecular structure, through which the fluids meander, as may be demonstrated by the microscope.

Pursuing the course heretofore adopted, in examining the functions of the economy, a general outline of the apparatus executing absorption will be the first subject of consideration.

Sect. I.—*Apparatus of Absorption.*

The general view presented of the function of absorption indicates a diversified mode of action, and a varied apparatus. The elementary, or molecular absorption, is evidently a property of the structure in which it occurs, independent of special organs: it is a molecular action. This is, probably, the rudiment, or the commencement of the absorption of the lymphatic vessels themselves; but it is too recondite, and passes too deeply in the organism to have its positive character clearly determined. This species of absorption exists in the cellular tissue, the serous and mucous tissues, the elastic fibrous tissue composing the vessels, as has been established by the experiments of M. Fodera and M. Magendie, and may be regarded as attached to all the solids. This species is very analogous to imbibition, and it explains the mode of action of many remedies whose effects are obtained by applying them in the vicinity of the part modified by them.

Absorption was for a long period, and until within a few years, supposed to be the exclusive office of the lymphatic vessels, or absorbents, as they were called. This system of vessels enters into the composition of nearly all the organs of the economy. It takes its origin from all the internal and external surfaces, and from the intimate, interior texture of the organs: it terminates by two central trunks, opening into the subclavian veins, close to the termination of the venous system itself in the heart. The vessels of this system anastomose infinitely, and their course is interrupted by numerous small bodies, called ganglions.

The absorbent system has been separated into two divisions:

the chyliferous, either mediately or directly communicating with the cavity of the small intestine, and terminating in the reservoir of Pecquet; and the lymphatics, arising from other surfaces and portions of the body, and finishing as already mentioned. This division is not founded on a difference in the structure of these vessels, but on the respective offices in which they are engaged.

The lymphatics follow the course of the veins, and like them present two layers, one superficial, under the skin, and the other profound, accompanying the deeper vessels. They are furnished with numerous valves, formed by a duplication of their inner membrane, and placed at unequal distances. They are supplied with blood-vessels, and, probably, nerves, though they are not to be detected.

The mode of origin of the lymphatics is yet a subject of controversy. Hewson and Monro believed they commenced with open orifices; but this is denied by Fohmann, who asserts, that in fishes he has observed their commencement to be in a cul-de-sac.

It has been advanced by Professor Lippi, that he has succeeded in discovering direct lateral communications by large trunks between the lymphatics and veins. Fohmann declares that in this respect an error has been committed, and that veins were mistaken for lymphatics: in this opinion he is sustained by the accurate researches of Dr. Rossi, of Bologna, who has shown these supposed lymphatic vessels to be venous trunks.

The ganglions are flattened, oblong bodies of various sizes, from that of a small millet seed to that of a bean: they occur at unequal, but short intervals along the course of the lymphatics; are of a pale reddish-white colour, except in the lungs, where they are blackish, and yellow near the liver; they are seldom isolated, being generally placed in groups.

The structure of the ganglions is not positively decided. They have been regarded as composed simply of lymphatics, infinitely convoluted. But the more general doctrine represents them as consisting of the lymphatics, convoluted, anastomosing together, and divided into cells in the manner of the veins of the penis. The vessels entering the glands are called *afferent;* those passing out, less numerous than the others, are named *efferent.* The ganglions are richly supplied with blood-vessels, both arteries and

veins, ramifying between the small cells of its interior, somewhat analogous to the erectile tissues. It is asserted by Fohmann and Meckel, that a direct communication exists in the ganglions, between the lymphatics and the veins, by which substances are introduced immediately into the circulation. This opinion is countenanced by the smaller number of *efferent* than *afferent* vessels; and appears further to be established by the matter of injections into the lymphatics, passing in the ganglions into venous trunks; yet this circumstance must not be too exclusively relied on, as the force of the injection may cause an artificial communication.

The veins, before the discovery of the lymphatics, were supposed to perform the office of absorption. But, after the experiments of J. Hunter, all participation in this function was denied to them. Whatever may be the doubts entertained as to their concurrence in general absorption, they are the agents, unquestionably, of absorption for the sanguine or nutritive humour from the spongy or areolar texture of the organs.

The commencement of the veins is so deeply buried in the minute structure, as to be observed with difficulty. It is a common opinion entertained by the physiologists of England and this country, that the veins and arteries are continuous, the one into the other, forming a closed system, and a direct unbroken circulation. This is certainly correct in some respects. In examining the circulation by the microscope in diaphanous membranes, the blood can be seen to make a circuit, changing its course from a centrifugal to a centripetal direction, evidently passing from an artery into a vein. A very limited portion only of the circulation, however, exhibits this phenomenon; for the larger portion of it no direct return is apparent. The globules of the blood pass off in diminishing channels, until every appearance of vascularity ceases. They, then, move with great irregularity in various currents, some with extreme velocity, others with a scarce perceptible motion, and without a positive direction. Many are arrested, and become fixed; and in parts where no movement was discernible, currents of globules are suddenly formed, giving the appearance of a vascular structure. Such is the character of the last circulation, as it has presented itself to me, in repeated observations

made with the microscope. The circulation in this portion of it ceases to be conducted by vessels; it is clearly extra vasa, and is seated in an areolar and interstitial structure.

The sanguine globules of this interstitial or areolar circulation, are reconveyed into the general or vascular circulation by the venous radicles into which they are introduced by the process designated absorption. It is in this manner the veins absorb, or remove the blood from the erectile tissues, when the excitement directing the blood into them has ceased; as in the penis, nipple, &c. It is this process, also, that disburdens inflamed and irritated parts of the blood effused by the congestion attending those states, and which often persists after their cessation.

The precise structure of the venous radicles, too delicate, and too intimately woven into the minute structure, like the lymphatic radicles, to be detected by our means of observation, remains unknown. Of the veins, the conductors of the absorbed fluids and refluent blood, it is unnecessary to add any further description to that already given in the first part of this work.

There is one portion, however, of the venous system meriting a particular notice: it is the vena portæ, or the portal system. The blood distributed to the abdominal viscera for the purposes of nutrition and secretion, is collected into delicate capillary veins; these pass into larger branches, and, finally, form one large trunk. This trunk, entering into the liver, divides again into numerous branches, terminating in capillaries. It is perfectly clear that the movement of the sanguine fluid in this system cannot be accomplished by the impulsive action of the heart: neither is it effected by the veins proceeding from the various organs, or from the vena portæ itself, nothing in their structure endowing them with a force of the kind. The movement of the portal blood must, then, be derived from the capillary extremities, or by a force impelling it on the one part, and attracting it on the other. The portal circulation throws light on the general venous circulation, and removes the necessity of calling into its aid the power derived from the contraction of the heart.

The venous radicles of the mesaraic veins, forming part of the portal system, take their origin in the villosities of the intestines. Lieberkun, Meckel, and Ribes, by injecting these veins, have

filled the villosities of the intestinal mucous tissue, and have seen the substance of the injection ooze into the cavity of the intestine. The same circumstance occurs in injecting the lacteals; exhibiting nearly a similar origin to both these vessels.

Sect. II.—*Of Chyle and Lymph.*

Chyle is the fluid found in the lacteals, or chyliferous vessels, and thoracic duct, from two to four hours after taking food. It is formed from the nutritive elements, prepared by the digestive processes already described, and taken up from the cavity of the intestinal canal. Chyle is not the product of digestion, for it is not detected in the contents of the alimentary tube: its first appearance is in the lacteals themselves, and it does not present its perfect characters until it has passed the mesenteric ganglions.

The elaboration of chyle from its crude principles, derived from the products of digestion in the small intestines, is the function or office of the lacteals and their ganglions, and this fluid, or humour, acquires animal properties in its progress through this apparatus. According to the experiments of Emmert, Gmelin, Tiedemann and Vauquelin, the coagulability of the chyle, its reddish tinge, and its approach to the characters of blood, are in proportion to its advance towards, and along the thoracic duct.

The chyle is not uniform, but varies in some respects, according to the nature of the food. It is always of a white or milky colour when animal, fatty, or oleaginous substances have entered into the diet. This appearance is due to the presence of oil in the chyle, for, when treated by sulphuric ether, which dissolves the oil, it becomes diaphanous. The chyle proceeding from vegetable aliment is always transparent.

Chyle, according to Marcet, formed of vegetable or animal food, presents other differences. The first contains more carbon than the second; it yields likewise much less sub-carbonate of ammonia; and its coagulum is less putrescent. Magendie states that the chyle from sugar contains less fibrin than that from flesh; and that the serum, coagulum, and fatty matter of the chyle, varies constantly, according to the nature of the food. Other differences, though they have not been made the subject of observa-

tions, doubtless exist, derived from the kind of aliment: food of a bad and innutritious quality cannot furnish good and wholesome chyle, and is often a source of disease.

Colouring, odorous, and other adventitious matters mixed with the food, do not affect the chyle. The contrary was supposed to have been established by the experiments of John Hunter, who believed he had witnessed the colouring matter of indigo in the lacteals. But it has been shown by Drs. Lawrance, Coates, and Harlan, of this city, in their experiments on absorption, that, in this respect, that distinguished physiologist was deceived by an ocular illusion. It is now perfectly well determined by the experiments of M. Magendie, and others, that the chyle is not affected by foreign matters mixed with the aliment, or introduced into the intestinal canal.

The *lymph* is less accurately known than the chyle. From the observations to which it has been subjected, it is represented as a transparent, colourless fluid; though it is said by some to possess a light rose tinge: it is viscous, and essentially albuminous. Its chemical composition exhibits some analogy with that of the blood: it coagulates, separating into a serum similar to that of the blood, and a coagulum.

The origin of the lymph is not absolutely decided. M. Magendie, who denies entirely lymphatic absorption, regards it in nearly the same view as the ancients. He believes it to be a portion of the blood returned back to the circulation through the lymphatics, as venous blood is returned through the veins. Lymph on this hypothesis is white blood. Many ingenious, and some forcible arguments, are deduced in favour of this opinion. It is not without foundation, but its error is in being too exclusive.

Many tissues, in their natural state, do not admit into them red globules: their circulation consists entirely of white blood; their nutrition is derived wholly from white fluids; such are the serous, the fibrous, the cellular, the cartilaginous tissues, and, probably, the large portion of the medullary nervous tissue. Now, this portion of the sanguine nutritive humour constitutes, it is more than probable, the lymph; for, no other fluid approaches as closely to the blood in its characters, and is, consequently, as well adapted to vital actions. The white blood, or nutritive hu-

mour of the white tissues, and the lymph may, then, be regarded as the same fluid; and it is the office of the lymphatics to restore it back to the circulation. But while this is a specific office of the lymphatics, it is not incompatible with a function of absorption. It is singular that M. Magendie should have so strenuously contended for absorption by the veins as an addition to their office in the circulation, and yet have excluded it wholly from the office of the lymphatics. The two systems of vessels possess so close an analogy, that functions of the same order may fairly and safely be attributed to them.

The lymph may, then, be considered as derived from the excess of the nutritive fluids of the white tissues returned into the circulation, and of the disengaged molecules of these tissues set free in the decomposing process of their renewal by nutrition. With it, will also be mixed extraneous matters, that may accidentally happen to be placed within the sphere of the white fluids.

Sect. III.—*Mechanism or Process of Absorption.*

The mode in which absorption takes place, has excited the curiosity, and embarrassed the ingenuity of physiologists to explain. Various hypotheses have been devised for this purpose; few of them, however, pretend to any positive facts in their support. It is generally supposed that the lacteals open into the intestines by patulous orifices, and the chyle, entering into them by capillary attraction, is, then, transmitted by a contractile power in the coats of the lacteals. It is a conjecture of Bichat, that the orifices of the lacteals are endowed with a specific sensibility, which causes them to admit the chyle, and to reject all other matters. These are little more than supposititious conjectures, and very slight evidence to the correctness of any one of them can be adduced. Resort has been had to these explanations, as it appears to have been generally admitted, that no other than physical powers existed to produce the movements of the fluids. Other forces do exist, as will be shown; and, hence, the admission of those hypotheses is entirely unnecessary.

The lacteals bear a very striking analogy to the roots of plants. These absorb from the soil the nutritive elements of the vegetable, prepared by decomposition, or putrefactive fermentation:

those absorb the nutritive elements of the animal, from the intestinal canal, prepared by the process of digestion. The means adequate to the process in the one, it is a fair inference, are those employed in the other. Now, it is positively determined, the roots of plants have no vessels with patulous openings, but terminate in a cellular texture, named, by De Candolle, spongiole, with which are connected the lymphiferous vessels conveying the sap, or absorbed fluid, to the leaves. Capillary attraction, consequently, can have no participation in the process. As little influence also has contraction, or the principle, contractility, whose existence is assumed for the purpose of this explanation, in producing the transmission of the absorbed fluids in the lymphiferous or sap vessels; for, some of these pass through the duramen, as well as the alburnum, which is dense, and can admit of no contraction: they may be regarded nearly as inorganic tubes. Besides, M. Dutrochet has established most clearly by his experiments, that the power, impelling the movement of the sap, proceeds from the spongiole. This power possesses great force; the experiments of Hales, corroborated by those of Mirbel and Chevreul, show that, in the vine, it is capable of raising a column of mercury from twenty-nine to thirty-three inches above its level. Now, the spongiole is too delicate in its structure to display a force of this kind by its physical properties, and it must proceed from a source, wholly unconnected with physical powers.

The absorption of fluids, and their movements in the vessels of plants, being shown to proceed from other sources than capillary attraction and vascular contraction, the same force, and mode of operation, are fully adequate to the actions in the lacteals of animals.

This force M. Dutrochet has demonstrated by a consecutive series of experiments and deductions, happily conceived, and philosophically arranged,* to be an electric phenomenon, and to have existence whenever vesicles, pouches, or sacks, either animal or vegetable, containing a fluid, are in contact with a fluid of less density: the last is then constantly introduced within the vesicle or pouch, and, if a tube be attached to this, will rise in it to a considerable height. This power M. Dutrochet has named *endos-*

* L'Agent Immédiat du Mouvement Vital, &c. Par M. H. Dutrochet.

*mose.** The experiments of Dutrochet have been repeated and extended at my suggestion by Dr. Togno, of this city,† who has verified their accuracy. It is besides well known, that galvanic currents are capable of transporting, not only fluids, but even solid substances through pervious tissues.

We arrive thus at the evidence of the existence of a force, capable of producing all the phenomena of absorption, the progression of the lymph and chyle, and of the capillary circulation, without having recourse to the hypothesis of capillary attraction, and a contractile power in capillary vessels. We have, in addition, the demonstration that this force can be brought into activity in organized tissues, producing the absorption and adfluxion of fluids; and we have established, consequently, the very strong probability, that the introduction of the sap, and its circulation in plants, and of chyle, and its progression with that of the lymph in animals, are accomplished by this force, and in a manner analogous to artificial endosmose.

In the present state of our information, it is not prudent to advance beyond the simple indication of the agent, which, strong probabilities justify us to believe, accomplishes absorption; and the general manner of its performance. The minuter details must be left to future periods, when they will be placed within the reach of explanation, from the facts evolved by profounder observation, multiplied experiment, and more extended research. The cultivation of electro-dynamics, developing a knowledge of their forces, and their application to physiological phenomena, will, I do not question, clear the path of the medical philosopher of a large portion of the difficulties that now impede his progress, and render that clear and explicit which is now dark and confused.

A question much agitated within a few years, and yet awaiting a decision, is venous absorption. M. Magendie would restrict general absorption exclusively to the veins, while many continue to believe, with J. Hunter, that the lymphatics alone are the agents of absorption. The majority of sound physiologists are,

* Ἔνδον, within; ωσμος, impulse.

† Experiments on Endosmose and Exosmose. American Journal of the Medical Sciences, May, 1829.

however, disposed to admit this function to be exercised by both systems of vessels; and this inference might, a priori, have been drawn from the similarity in the structure of the two, their close connexion, and the analogy of their offices. In the brain anatomists have been as yet completely foiled in detecting lymphatics, and if they do not exist there, the absorption of the arachnoid fluid, &c. must be effected by venous radicles.

Those who deny venous absorption, in order to avert the force of the experiments of Magendie, and his supporters, allege the existence of very short and minute lymphatics, communicating with the small veins at their commencement, and in the lymphatic ganglions, through which foreign substances gain an immediate admission into the veins. Fohmann asserts he has detected absorbents of this kind. This species of anastomosing between the veins and the lymphatics at their commencement, countenances a conjecture entertained by some, that the two systems of vessels have a common origin, and are distinct only when formed into vessels. By this arrangement, water, foreign substances, and those matters not intended to be assimilated, but to be rejected by the emunctories, are immediately introduced into the veins; while chyle and lymph, designed for nutritive processes, are carried into the general lymphatic system, subjected to the actions of the ganglions, and are advanced in a state of assimilation, when they have reached the venous system. A view of this kind has been proposed by Dr. Geddings, of Charleston, S. C. in a well-written essay on Absorption, in the Philadelphia Journal of the Medical and Physical Sciences, Vol. XIV. He, however, argues, that the separation takes place in the ganglions.

It is very certain, from the concurrence of reiterated observation and experiments, that, during the absorption of chyle by the lacteals, water, alcohol, and other matters, are not taken up by them. These substances cannot be detected in the chyle, while their presence is readily verified in the mesenteric veins. This fact explains the rapidity with which drinks, &c. are discharged from the bladder, or detected in the urine, without resorting, with Sir Everard Home, to the violent conjecture of a direct communication between the stomach and bladder; or the equally forced explanation of Darwin, of an inverted action of the absorbents.

The cellular tissue and lymphatic system have a greater predominance in infancy and in females, than in riper age and in males. They have, consequently, an acute susceptibility, and are exceedingly liable to assume a morbid state in early life and in women. This disposition is lost with advancing years, and in age these tissues diminish in their relative proportion to the others: their diseases are, then, rarely met with.

The activity of absorption appears to hold a relation with the state of the circulation. When the vessels are plethoric, absorption languishes; and it acquires great activity by the diminution of their contents. This fact is fairly established by the experiments of Magendie, who found an artificial plethora, produced by injecting water into the veins, to prevent the poisoning of nux vomica inserted under the skin; and which ensued in shorter periods, according to the quantity of blood abstracted by bleeding. From this circumstance is seen the propriety of preceding the exhibition of those medicines whose effects proceed from their absorption, with depletion or abstinence. The same means should also be resorted to when it is desired to bring the absorbent functions into action in the treatment of disease; as the removal of indurations, tumours, effusions, &c.

Absorption, when it is languid or suspended, may be roused into activity by the direct application of excitant means. In this way the congestion caused by inflammation, and which often persists after the inflammatory action has subsided, is speedily dissipated by stimulants directly applied. This is seen in conjunctivitis after the acute stage has passed: any stimulant almost applied to the conjunctiva will remove the congestion which alone remains. Indolent white tumours, and enlarged ganglions, when no sanguine irritation exists, are also frequently dissipated by irritating applications, as of iodine, and its preparations, &c.

Sect. IV.—*Pathological State of the Function of Absorption.*

The pathology of the absorbent system and function is far from having attained the precision and development that are desirable. Our information on this point is imperfect and obscure, and the etiology of their affections must prove unsettled and unsatisfactory, until our knowledge of the function itself be more definite and enlarged.

The lymphatic system is endowed with feeble sympathies, and is not very readily disordered by transmitted irritations of remote organs, except in those of a highly lymphatic temperament.

The diseases of the lymphatic system are of two different orders, that have not, heretofore, been properly discriminated. The one is the *inflammation or sanguine irritation* of the lymphatics and ganglions, analogous to inflammation in any other tissue, and affecting the mode of their nutrition: the other is disorder of its functional actions, affecting the mode or performance of its absorbing and its assimilating actions, or *simple lymphatic irritation.*

The principal source of the *inflammation* of the lymphatic system, are impressions on the surfaces in which its radicles are seated, or irritations excited in those surfaces: it may also proceed from offending causes introduced by absorption.

The functional disturbances producing lymphatic inflammation depend chiefly on the predominance of the cellular and lymphatic tissues, and an excess of lymphatic fluids. With this state constantly exists extreme susceptibility of the capillaries and structure connected with the lymphatic circulation, and which, consequently, suffers with facility aggressive impressions.

The inflammation or sanguine irritation of the mucous tissues, very rarely fails to be extended into the lymphatics arising from them. This fact was announced by Bichat, but has received much greater elucidation, and been placed in a more conspicuous light, by the researches of M. Broussais. The enlargement of the mesenteric ganglions, the result of their too active nutritive actions, and their suppuration, are always the consequence of enteritic irritation. This condition of those ganglions has been regarded as a specific disease, and as interfering with nutrition, by preventing the absorption of chyle. The emaciation of the patient is not, however, a consequence of any obstruction in the ganglions, as is supposed, for injections pass them with facility. It is to be accounted for by the imperfect chylosis, or production of chyle, the process of which is interrupted by the irritation of the digestive mucous tissue; by the disorder attending on absorption, caused by the morbid state of the mucous tissue in which the lacteals arise; and by the defective assimilation produced by

the inflammation of the lacteals, and especially the mesenteric ganglions.

Inflammation, and especially, ulceration of the skin, is a common cause of inflammation in the lymphatic ganglions in the vicinity of the part affected. The neighbouring lymphatics will be seen inflamed, marked by a red streak on the skin, painful and hard to the touch; and the ganglions will become tumefied and suppurate. In this way are buboes formed by ulcers on the penis, by inflammation of the urethra, and by inflammations on the toes, &c.

The sanguine irritation, or acute inflammation of the lymphatics, is well characterized by the usual evidences of inflammation. They are red, tumefied, and painful. The ganglions, when inflamed, enlarge rapidly, become acutely painful, and suppurate easily. The tumefaction is confined chiefly to the gland, is hard and resisting, painful on pressure; it is generally well defined, and when advancing towards suppuration, the skin is of a clear red. The suppuration usually consists of laudable pus. The inflammation of the lymphatic ganglions occurs in those of the sanguine temperament.

A very different condition is frequently produced in those of the lymphatic temperament, and by the very same causes which have given rise to the preceding form of inflammation in the sanguine. The tumefaction is diffused around the ganglion, is doughy to the feel, but sometimes hard; it is but little painful, though in the nervous, and when renitent, it is occasionally sensible; and the skin is generally white or but slightly reddened. A sense of fluctuation is often perceptible, leading to a supposition of a collection of pus; yet, if a lancet be introduced no pus is evacuated; blood mixed with lymph alone follows the puncture, and when the blood has ceased to flow, there is frequently a discharge of lymph solely. Purulent suppuration never, or certainly very rarely, takes place in this species of irritation, which is the proper lymphatic irritation. In these cases the irritating cause occasions a lymphatic congestion. The white fluids being most abundant, and their appropriate vessels and tissues the most susceptible, the phenomena of irritation are manifested in them, as in the sanguine it is manifested in the red fluids, their vessels and tissues. The lymph, or white fluids, are determined towards the seat of irritation, ab-

sorption is suspended, and a lymphatic congestion ensues, precisely in the manner that red blood, in the sanguine temperament, accumulates around the point of irritation, and produces sanguine congestion. Instances of this kind I meet with constantly in individuals highly marked by the lymphatic temperament. I had a female patient, a married woman, affected with gonorrhœa by her husband, whose left groin, and a large portion of her abdomen presented this state of lymphatic engorgement. It is produced sometimes by chancres; I have seen it follow a furunculus on the thigh; and many cases of it caused by exposure to cold. I have known surgeons who misunderstood its character, and who insisted on its syphilitic origin in such instances.

The chronic state of this form of irritation in the lymphatic tissues and circulation, constitutes scrofula, and gives origin to tubercles in the lungs and other organs, and to scrofulous tumours in the neck, groins, &c.

It is highly important to make the discrimination between the sanguine irritation of the lymphatics, and this last form. For, while poulticing and warm fomentations give relief in the first, and promotes a healthy suppuration, in the last or simple lymphatic irritation, they enlarge and extend the swelling, increasing the lymphatic congestion and effusion of white fluids, and rendering the disease more inveterate.

M. Broussais has recognized this form of irritation, which he names sub-inflammation. He has not, however, explained its phenomena, or appeared to understand the mode of their production. He further makes no discrimination between its acute and chronic degree, and does not sufficiently distinguish between it and the sanguine irritation or inflammation of the lymphatic vessels and ganglions. The acute state of it does not appear to have struck his attention, and his observations are, as far as I have seen, confined solely to the chronic degree.

From not enlarging on the nature of the phenomena of lymphatic irritation, or sub-inflammation, as he terms it, some of his pupils reject it as unfounded. This is the case with M. Begin. The objections of this gentleman turn on two points: the first is, that the anatomical disposition of the lymphatic vessels must cause their fluids to flow from the periphery to the centre, and, consequently, cannot admit the congestion, or a radiatory con-

vergence and accumulation of lymph towards an irritated point, as occurs with red blood: and second, that on anatomico-pathological examination, the evidences of inflammation are found as in other tissues.

The first of these objections is founded on an entire misconception of the lymphatic system, and of the phenomena of its irritation. The lymphatics are the returning vessels of the lymph, or white blood, as the veins are the returning vessels of the red blood. The lymphatics absorb the white blood from the capillaries and areolar tissue, into which it alone penetrates in a natural state, as the veins absorb the red blood from the capillaries and areolar tissues in which it circulates. The lymphatic trunks are no further concerned in the phenomena of lymphatic irritation, than the veins are in sanguine irritation or inflammation. Lymphatic irritation is seated in the lymphatic capillaries, and the tissues in which white fluids alone penetrate, in the same manner as inflammation is seated in sanguine or red capillaries, and the tissues nourished by red blood. The lymphatic trunks or vessels are foreign to lymphatic irritation, as the venous trunks or vessels are foreign to inflammation or sanguine irritation. It would be as valid an objection to the existence of sanguine irritation, that the veins do not admit a retrograde course of their fluids, as it is to lymphatic irritation, that the lymphatics do not suffer a retrocession of their fluids. The first objection of M. Begin is, then, invalid; possesses no cogency, being founded on a misconception of the phenomena composing lymphatic irritation, or the sub-inflammation of Broussais.

His second objection is equally destitute of weight. It arises from confounding the sanguine inflammation of the lymphatic ganglions, always developed in the advanced progress of their diseases, with simple lymphatic irritation. Besides, lymphatic irritation is not necessarily connected with enlarged lymphatic ganglions. They are often inflamed independently of any affection of the lymphatic capillaries, and these sometimes manifest the characters of their peculiar irritation, while the ganglions remain unaffected.

Lymphatic irritation is productive of various morbid changes in the lymph or white blood, and in the mode of nutrition of the white tissues. The most common production of this kind are tu-

bercles, developed with so much facility in the lungs, compressing and destroying their tissue, in those endowed with the lymphatic temperament. Tubercles, though more frequently formed in the lungs than in other organs, are found in most of the tissues. Next to the lungs the serous membranes are most frequently their seat, but they occur in almost every portion of the animal structure.

The nature and production of tubercles have been subjects of constant discussion. Bayle and Laennec, with very little evidence to support their opinions, regard them as possessing a distinct vitality from the surrounding tissues, which have no share in their production; and that they are a species of morbid organized tissue. Baron, on grounds no stronger, supposes them to be, in their origin, a species of hydatids, subsequently becoming concrete and converted into tubercles. These opinions are not entitled to weight, being little more than bare conjectures.

Tubercles do not exhibit, according to Gendrin, the globules of fibrin, or of true pus, but yield albumen on examination. They occur most readily in those of the lymphatic temperament, in whom the white tissues, and the lymphatic fluids, (which are albuminous,) are predominant, and in their commencement, contrary to the assertion of Laennec, they are fluid, or of a soft consistency. Tubercles are, then, it is most probable, a species of lymphatic pus, or a morbid secretion resulting from an irritation in the lymphatic vessels and tissues in which the white fluids circulate; and whose characteristic property is to assume the concrete state.

The opinion in respect to their production, entitled to most consideration, and which I have found in my researches sustained by observation, is that of M. Broussais. This distinguished pathologist places their seat in the white capillaries and lymphatic ganglions, and attributes them to an irritation developed in those tissues. This irritation of the white capillaries is frequently excited by sanguine irritation or inflammation in adjacent tissues. Inflammation, for instance, of the bronchial mucous membrane, will give rise to the formation of tubercles in the parenchyma of the lungs.

The irritations of both sets of capillaries, the red and the white, are often also concurrent, as is seen in some cases of pneumonic

inflammation, in which tubercles are developed amidst the alterations of structure proceeding from sanguine irritation. M. Broussais has not sufficiently distinguished between the two irritations to render his meaning clear and distinct. Hence, Laennec, Gendrin, and Louis, who oppose his views, found their objections entirely on grounds irrelative to the question. Their arguments turn entirely on *sanguine irritation or inflammation*, as the proximate cause of tubercles, while it is only asserted to be one of the occasional or exciting causes of *lymphatic irritation*, the proper proximate cause of the formation of tubercles.

The lymphatic capillaries, the white tissues, and the albuminous fluids, are the subjects of other morbid formations, a consequence of irritation provoked in them, and giving rise to a perverted mode of nutrition—such are scirrhus, encephaloid tumours, and other morbid formations of a cancerous nature.

Absorption we have presented as a function equally exercised by the veins and lymphatics, and intimately concerned in the nutritive movements of the fluids, or the circulation, as it is generally termed. If this view of the function be admitted as correct, it must enter as an element into the morbid states of the circulation, or the movements of the fluids. In inflammation a stasis of the fluids exists, they accumulate in the part where this state has been excited, and a congestion is produced. This condition does not arise from any difficulty in the direct circulation, or that where the blood passes immediately from afferent or arterial into efferent or venous vessels, for the veins proceeding from an inflamed part are distended with blood, and fill up rapidly if the blood be pressed out of them. The congestion, then, must proceed from the suspension of absorption by the venous radicles, the mode in which the blood is returned back into the general circulation from the capillary and interstitial, or areolar circulation. This circumstance has been overlooked in all the theories of inflammation, yet it appears to me to constitute one of its essential characters.

The defect of venous absorption frequently subsists after the first period of irritation has passed away, and the congestion, or blood stagnating in the tissue, continues from this cause. The application of an excitant in this state, by awakening absorption, occasions an almost immediate disappearance of the redness and

tumefaction that have remained persistent after the cause inducing them had ceased. This passive condition is often confounded with the active period of inflammation, and those who do not understand the different phenomena comprehended under the term inflammation, are led into false conclusions, and sometimes most erroneous practice, from the fact above stated: they suppose it an evidence that inflammation can be cured by excitants, and are induced to resort to their employment in the active periods of inflammation; a practice fraught with great hazard to the integrity of the organs and life of the patient.

The same defect of absorption occurs in simple lymphatic irritation, and the congested lymphatic humours collect and stagnate in the tissue where the irritation is developed. Hence proceeds the tumefaction, generally colourless, that attends it, and the lymphatic fluids which issue when an opening is made.

The collection of serous fluids constituting the various forms of dropsy, has been attributed to defective absorption in the lymphatics, independent of any inflammatory action. It was supposed that an equilibrium existed between the exhalation of the serous sacs and cellular tissue, and the absorbing function of the lymphatics, and that a loss of power in these last, suspending their function, was sufficient to cause an accumulation of the exhaled fluid, and to form dropsical collections. This doctrine is, however, a pure hypothesis, and is not substantiated by any positive facts. In the experiments of Munro and of Dupuytren, who secured the thoracic duct in animals by ligatures, no dropsical swellings were induced by the suspended function of the lymphatics. Sir Astley Cooper has recorded a case of obliteration of the thoracic duct, in which also no dropsical collections had occurred; and the same circumstances have been observed by M. Andral, the younger.

On the contrary, ligatures on the veins, and obliterations of those vessels by the inflammation of their lining membrane, an occurrence by no means rare, are invariably productive of dropsical effusions, showing that the serous portion of the sanguine fluid is absorbed and returned into the circulation by veins, and not by lymphatics. From the defects of absorption, by the obliteration of the cavities of venous trunks, or other causes impeding

the transmission of the blood through them, dropsies may frequently be induced; but the most usual proximate cause is inflammation of the serous sac, or the cellular tissue, in which the effusion exists.

The milk leg, as it has been termed, or phlegmasia alba dolens, succeeding so frequently on parturition, it would appear from recent examinations, proceeds from inflammation of the large trunks of the veins obliterating their cavities by the formation of coagula or fibrin. In this disease the cellular membrane of the affected limb is distended with a sero-albuminous fluid, causing a dense tumefaction: absorption would appear to be suspended by the loss of function in the veins.

Absorption may deviate from its normal state by its too great activity. It occurs as a symptom in different diseases, but cannot be regarded as a distinct affection. In fevers emaciation is rapidly produced by the absorption of the fat and cellular fluids; but in chronic affections every portion of the structure is wasted, even to the substance of the bones, constituting *atrophy*. I witnessed a case of atrophy attended with severe pain in the extremities and the trunk, and with extreme tenderness to pressure. The appetite was good, the nutrition abundant, and the gastric digestion free of embarrassment. The wasting of the frame, notwithstanding, gradually progressed, and arrived at the last possible extent. After death chronic inflammation and ulceration of the lower bowels were found to exist, but, from the regularity of the alvine discharges, and their natural appearance during the earlier periods of the disease, it is doubtful whether they did not occur only a short time previous to its close.

Absorption, composing part of the complex phenomena of which nutrition consists, enters into the deviations disturbing the order of this function. In a healthy state, a certain equilibrium is maintained between the processes of composition and decomposition composing the nutritive function. It is not uncommon for this equilibrium to be lost, and the balance be directed to the one side or the other without a positive perversion of the function: when the process of composition possesses the ascendancy, nutrition is in excess, and hypertrophia prevails; when decomposition and absorption obtain the superiority, atropia, or the

wasting of the solids, is the predominant phenomenon. In a morbid condition, perversion of the function ensues, and absorption, when unduly active, occasions thinning, softening, ulceration, and other modes of the destruction of the tissues.

CHAPTER III.

Function of Respiration.

THE humours or fluids of chyliferous, venous, and lymphatic absorption, reunited in the right cavities of the heart, or the moving organs of the black blood, are destined to the formation of the especial nutritive humour, or arterial blood, from which immediately proceed the nutrition, and most of the secretions of the animal economy.

Their conversion into blood, or hematosis, is accomplished in the pulmonary apparatus into which they are propelled by the contraction of the right ventricle, and by the function of respiration, of which the lungs are the organs.

This conversion of the nutritive element, or the humours of absorption into blood, or the nutritive humour, is effected by the absorption of a principle of the atmosphere, oxygen, and the excretion of some component elements of the organization, principally carbon.

The reciprocal action between oxygen and the nutritive elements, is a process essential to the production and continuance of vital phenomena. Without this action they are never developed, and they terminate when it is suspended. This law is universal —no exception to it exists. It prevails in the simplest and rudest form of organization, as fully as in the more complicated and perfected. This action is the completion of the series of processes to which the nutritive elements contained in the aliment undergo, adapting them to become organized matter, and endowing them with the susceptibility of manifesting vital phenomena. Respiration and the function of hematosis must, consequently, be intimately associated with the digestive functions, and a correspondence or relationship must exist between them.

The methods by which respiration is effected, like those accomplishing digestion, are exceedingly diversified. Nature delights in variety. Every order of beings presents some particularities in the same functions, as well as in their form and structure. In the animals of simpler organization, into which the nutritive elements enter by direct absorption, the atmospheric air is introduced in the same manner to exercise its influence. Respiration, like digestion, if the terms can be applied, is with them a species of imbibition, and takes place on the external surface. Every portion of the structure is the seat of the mutual action of the nutritive elements and oxygen, essential to vital susceptibility, and each portion possesses, consequently, in itself, the requisites of its existence. But in those beings provided with a distinct surface, or separate organs for digestion, or the preparation of the elements of nutrition, a distinct surface or particular organs are provided for the reciprocal action of those elements and oxygen, and the function of respiration, and a respiratory apparatus, are developed and complicated exactly in proportion to the development and complication of the apparatus and function of digestion. Thus, in the animal reign, respiration is accomplished through spiralces and tracheæ, ramifying together with the tubes conveying the nutritive fluid proceeding from digestion, and introducing the atmosphere into the interior structure; or by gills of various form in those constantly immersed in a fluid; or by lungs in the animals of higher order: and in vegetables of the more perfect kind by leaves.

Notwithstanding the exceeding diversity of the means employed by nature, the essential feature of respiration is the same in all, and is similar to the process as it exists in the simpler animals, that is, an absorption of oxygen, and its action on the nutritive elements, converting them into the nutritive or sanguine humour for the purposes of nutrition.

The dependance of vital phenomena on the respiratory function, is not equally absolute in all beings. The simpler animals are capable of surviving its suspension, or, what is the same thing, the deprivation of oxygen, for considerable periods of different length; but, in the more perfect animals, this dependance is immediate, and is proportionate to the rank of the being in the animal scale.

In man, and all animals of warm blood, respiration cannot be interrupted beyond a few moments without causing a total cessation of vital phenomena. In them, the lungs become, like the brain, a centre of vitality, whose integrity is a requisite for the soundness of the organization; and respiration is a vital function, whose unceasing action is indispensable to the maintenance of all the other functions of the economy.

In investigating the connexion of this function with physiological phenomena, and the pathological state, the plan heretofore pursued, with the functions previously discussed, will be continued.

Sect. I.—*Apparatus of Respiration.*

The apparatus of respiration, or the anatomical organs appropriated to the performance of this function, are numerous, and of very different kinds. A variety of organs are made subservient to its accomplishment, none of which can be dispensed with; a defect in any one of them is attended, according to the importance of the part it fulfils, with greater or less impairment of the function.

The apparatus of respiration consists of the air passages, (the nostrils and mouth, the fauces, larynx, and trachea;) the thorax and muscles executing the mechanical motions of respiration; the nervous organs governing these movements; and the lungs, the immediate seat of the actions or changes accomplished, the end of the function.

§ 1. *The Air Passages.*

The air passages transmit the atmospheric air into and out of the lungs. It enters and issues by the nostrils, opening posteriorly into the fauces, but when the passage of the nose is obstructed, the mouth, equally communicating with the fauces, gives it admission and exit. By this provision of a double entrance for the air into the respiratory apparatus, numerous accidents are avoided: respiration by the mouth alone, is, however, always painful and embarrassing. When the admission of air into the lungs is obstructed by mechanical obstacles, as by the engorgement of the lungs in acute pneumonia, effusions in suffocating catarrh, occlusion of the glottis in croup, and of the smaller bronchial tubes in some forms of asthma, the nostrils are instinctively expanded to their utmost, and dilate forcibly with each inspira-

tory effort. The object is to increase the volume of air, and to facilitate its passage, in order to obviate, as far as possible, the threatened suffocation. Except in asthma, the active movements of the nostrils in respiration, are always a sign of most unfavourable augury, indicating extreme danger to the patient.

The posterior fauces are a common passage for the purposes of deglutition and respiration, giving admission to food into the œsophagus, and of air into the larynx. In the office of respiration they are nearly passive, but inflammation, causing tumefaction of the lining mucous tissue, effusions into its substance, or suppuration beneath it, enlargement of the tonsils, and excessive swelling of the root of the tongue, by filling up this cavity, often occasion great obstruction to respiration, and may even produce death from suffocation.

The larynx is the organ of the voice, and has already been described. (Part I. Chap. VII. § 5.) The structure calculated to render the larynx perfect, as a vocal instrument, interferes with, and injures its fitness for respiration. The rima glottidis, so essential in the production of vocal sounds, by its narrowness, is rendered exceedingly liable to be obstructed. This occurs in croup, from the exudation of coagulable lymph on the surface of the mucous membrane, lining the aerial passages, and in œdema of the same tissue. Foreign bodies may also become entangled in the larynx, or enter the trachea, and are prevented from being expelled by the narrowness of this aperture; and, in consequence, prove highly disturbing to the function of respiration, or may induce suffocation. Injuries to the recurrent nerves, by paralyzing the muscles of the larynx, that impart to it a movement coincident with inspiration and expiration, entail the same result.

The mucous membrane of the larynx, when inflamed, maintains an incessant irritation, exciting cough. Ulceration is a frequent consequence, and the mechanical efforts of coughing, tend to perpetuate the disease. Hence arises the incurability of the affection. The function of the lungs is more or less disturbed by the violence and constancy of the coughing, and ultimately they become involved in the disease.

The trachea is intended expressly for the transmission of the atmospheric air into, and from the lungs, for which it is perfectly adapted. The mucous membrane lining it, when inflamed in

early life, very frequently throws out on its surface a secretion of coagulating lymph, forming a dense membrane, which becomes a source of serious embarrassment to the function of respiration. It is compressed also by tumours developed in the neck; by aneurisms; and, as I have witnessed in two instances, by diffused suppuration in the cellular tissue of the neck; all of which endanger the production of asphyxia.

§ 2. *The Thorax.*

The thorax is the bony case placed between the neck and abdomen. It contains the important vital organs—the heart, large vessels, and lungs. By its construction it is made to subserve for the defence of these viscera against injuries, for free movements necessary in the performance of respiration, and to accommodate itself to the motions of the body. These different objects are admirably accomplished by the manner in which it is arranged.

The thorax is composed of the vertebral column or spine posteriorly, of the sternum anteriorly, and of the ribs on the sides. To these are added muscular parietes, between the ribs, filling up their interstices, and the muscular septum, the diaphragm, dividing it from the abdomen.

In the movements of respiration, the vertebral column, or rachis, is a fixed point on which the ribs move in the acts of inspiration and expiration. The ribs are articulated to the vertebræ by an extremity covered with cartilage, received into a facet likewise covered with cartilage. At the sternal extremity they are not united immediately to the sternum, but are connected by the intervention of elastic cartilage. By this disposition of the ribs, great facility of motion is acquired, combined with a power to resist violence. If the union of the ribs and sternum was direct and solid, they would be liable to fracture whenever exposed to a violent concussion, and the chest could not be largely expanded, as is requisite in very active exercises, and powerful exertions. The elasticity derived from the cartilages, is, moreover, a very considerable aid in expiration, especially when great debility of the muscular system prevails. In advanced age, the cartilages connecting the ribs with the sternum are ossified, and their elasticity has disappeared. A certain degree of restraint is then experienced in their movements, preventing the expansion of the chest,

for the reception of the increased quantity of blood thrown into the lungs by an augmented velocity of the circulation. From this circumstance proceeds the incapacity for active exertions in advanced life: and it proves a source of danger, at that period, in all diseases imparting additional rapidity to the circulation.

The movements of the thorax in respiration are effected by different muscles, which may be divided into two classes: the proper muscles of respiration, engaged in the performance of ordinary respiration; and the accessory, or those only called into action at certain times, and in particular emergencies.

The movement of inspiration consists in the elevation of the ribs, and the depression of the diaphragm. Haller supposed the ribs were elevated successively from above downwards, the first rib being a fixed point; but it is now generally conceded with Magendie, that the ribs are all elevated at the same moment; and the consequence of this motion is to enlarge the thorax in its antero-posterior, and lateral diameters; while the sinking of the diaphragm augments its cavity from above downwards. The lungs contained within the thorax follow this movement, for they are always in contact with the parietes of the thorax.

Inspiration is ordinarily performed by the sinking of the diaphragm, and a gentle elevation of the ribs, and it varies very considerably in its extent, determined by various circumstances. It may be accomplished by the diaphragm alone, as is seen in severe cases of pleuritis, pleurodynia, &c.; or by the ribs alone, as occurs in violent peritonitis. In forced inspiration the ribs are very considerably elevated.

The movements of the thorax in expiration are the reverse of those producing inspiration. The ribs are depressed, shortening the antero-posterior, and lateral diameters, and the diaphragm rises. The cavity of the thorax is thus diminished, and the lungs within it compressed.

These movements are in part passive, being caused by the elasticity of the cartilaginous extremities of the ribs, pressing them downwards when the muscles relax; and in part active, especially in forced or laboured expiration, being effected by the contractractions of particular muscles.

The thorax has an operation in respiration analogous to that of a bellows; its expansion causing the air to enter the lungs, which is expelled from them by its contraction. The natural exercise

of the function of respiration depends on the regularity of these motions; and whenever they are interrupted or prevented, this function is deranged, and death from suffocation will ensue. This occurs in paralysis of the respiratory muscles from injuries sustained by their nerves; or by their permanent spasm, as in tetanus.

§ 3. *Of the Lungs.*

The lungs are the immediate seat of the respiratory function. The other organs of this apparatus are merely subservient for the introduction of the atmospheric air into them. In man, the lungs are of a vesicular, spongy texture; into the composition of which, numerous tissues enter. Taken together, they form an irregular cone, the base towards the diaphragm, the apex beneath the sternal extremities of the clavicles. They are divided into two, separated by the mediastinum formed by reflexions of the pleuræ, and containing the heart, which is thus placed between the lungs.

The lungs may be regarded as consisting essentially in innumerable divisions and ramifications of the trachea or windpipe. After entering the thorax, the trachea divides behind the arch of the aorta into two branches, that take the name of bronchi, or bronchiæ, one of which passes to each lung. The infinite ramifications, and sub-divisions of the bronchial tubes, terminate in closed extremities, or cul-de-sacs, forming the pulmonary vesicles, or air cells, of which the lungs appear almost entirely to be formed. The lungs may, then, with propriety, be regarded as hollow viscera, or forming an immense cavity, separated by innumerable septa, or divisions.

The trachea and bronchi are formed of fibrous tissue, of cartilage, of muscular, and of mucous tissues, which last lines the interior, and is, consequently, in contact with the air inhaled in respiration. In the last divisions, the cartilage, fibrous, and even muscular tissue disappear, and the mucous tissue alone continues. It is, however, exceedingly probable, that muscular fibres of extreme delicacy may accompany the mucous tissue to its termination.

The mucous tissue is the more important of these constituents, and the proper organ of respiration. This process is the function of the bronchial mucous tissue, the healthy condition of which is essential to its performance.

Many anatomists and physiologists regard this tissue as a reduplication or fold of the skin; an opinion now very generally admitted. Notwithstanding the complicated apparatus of respiration in the higher orders of animals and man, this function is, then, precisely similar in them to what it is in the lower and simplest animals, an imbibition, or absorption of oxygen, by the skin.

The bronchial mucous membrane, like the other tissues of the same kind, contains numerous mucous follicles, and in the trachea beneath this tissue, on its posterior face, are found muciparous glands. They are very numerous and large at its inferior portion near the bifurcation. It is also the seat of a watery, or perspiratory exhalation, which escapes incessantly in expiration in an insensible form, except when the temperature is sufficiently low to condense it into vapour. These secretions, especially the mucous, maintain the tissue in a soft, moist, and flexible condition, requisites for its adaptation to the respiratory office.

The object attained by an apparatus of lungs for the function of respiration, is an extended absorbing surface placed in contact with the atmospheric air. The bronchial mucous tissue, spread over the pulmonary air cells, offers a surface, according to the calculation of Munro, "equal to four hundred and forty square feet, or nearly thirty times greater than the whole surface of the body." Estimates of this kind are, however, always vague.

Another element of the pulmonary structure are blood-vessels. They consist of arteries, veins, and capillaries, and are of two orders; the pulmonary arteries and veins appropriated to the respiratory office; and the bronchial arteries and veins destined to the nutrition of the pulmonary tissues.

Between these two sets of vessels anastomoses frequently occur, not only in the fine capillaries in which they terminate, but, it is said, in the larger trunks and branches. Both are in intimate union with the mucous tissue of the bronchi. Injections made into either set of vessels pass into the other, and at the same time transude from the mucous membrane into the bronchial tube.

The pulmonary artery, like the aorta, is a vessel of supply, communicating with the pulmonary capillaries, and bronchial mucous tissue, into which it transmits the humours, or fluids of absorption, and in which is effected the process of hematosis, or

sanguification. The pulmonary capillaries form an immensely ramified net-work, or rather reticulated tissue, connected most intimately with the mucous membrane of the bronchiæ. The two constitute the principal portion of the pulmonary parenchyma. The spongy and permeable structure of the one, admitting of dilatation in the manner of the erectile tissues, and the meshy arrangement of the other, give a capacity of no mean amount for the reception of fluids, when the extent of the bronchial mucous membrane, and pulmonary capillaries, are taken into consideration: they are capable of containing a very large quantity of fluid. By this arrangement, the venous blood is divided in an infinite manner, and spread, as it were, into a sheet, over a most extensive surface, in which a considerable mass of it is constantly exposed, in separate molecules, to the action of the atmospheric air. It is the expansion, and the tenuity imparted to the sheet of blood, exposed in this way to the air, that enables the process of respiration to be performed with a rapidity equal to the celerity of the circulation in warm blooded animals, and to maintain an incessant supply of oxygenized, or arterial blood, for the demands of the organs.

The pulmonary veins receive the blood from the pulmonary capillaries, and bronchial mucous tissue, and conduct it, after experiencing the changes induced by the respiratory process, to the left heart, whence it is sent into the different portions of the economy for the purposes of nutrition, secretion, and the support of vital actions. The origin of the pulmonary veins, and the manner in which they receive, from the capillaries and areolæ of the bronchial mucous membrane, the blood they contain, and which has been subjected to the action of the air, are entirely unknown. It is to be presumed, they resemble, in these respects, the venous system in general.

The *bronchial* arteries and veins are important elements of the pulmonary structure, though less numerous than the *pulmonary*. The last are not adapted to the nutritive functions, the antagonizing operations of composition and decomposition, essential to the existing of vital phenomena in organized matter, and which must be unceasingly in activity in the structures composing the lungs. A separate order of vessels, of the same class as those of general nutrition, are required for this purpose, and they are the bronchial arteries arising from the aorta, and the

pulmonary veins, terminating in the vena cava and azygos. A distinct capillary system, it is presumable, is attached to this order of vessels, performing the office of nutrition, as in other portions of the animal structure. Haller and Reisseissen assert, that this order of vessels anastomose with those of the pulmonary artery. It is certain, that injections into the one, pass into the other; yet it may well be doubted, whether, in the living state, an identity of circulation does actually exist. There is some difficulty in admitting, that vessels, connected with functions differing so widely in their nature, should be thus closely associated; and more especially, that fluids, so dissimilar as the fluids of the pulmonary and bronchial arteries, and performing parts so different, should be confounded together by a common circulation. I do not know that the colour of the blood in the bronchial veins has been determined, but it is an enquiry well deserving investigation, to ascertain if it resembles venous blood, or has experienced a change by the respiratory process, like the blood in the pulmonary veins. From being returned into the venous system, it is most probably venous blood; and, in that case, on what principle is to be explained its exemption from the changes suffered by the blood of the pulmonary artery in respiration?

Lymphatics form another element of the pulmonary structure. They are spread over the exterior surface of the lungs, immediately beneath the pleura, forming a complicated plexus, with meshes corresponding to the lobules of those organs; and they arise also in great numbers from the interior structure. They follow the course of the pulmonary vessels and bronchial tubes, and pass out along with the ramifications of the trachea. No ganglions exist in the interior, or on the surface of the lungs, but numbers are arranged at their roots, into which the lymphatics enter.

Regarding these vessels as analogous to the veins in their office, a circulation of lymph, or white blood, the nutritive humour of the colourless tissues, with base of gelatin and albumen, must exist in the lungs. This order of tissues forms no inconsiderable portion of the pulmonary structure, and the colourless blood of consequence, abounds in them. The organic actions of these tissues, with their appropriate nutritive fluids, become frequently disturbed by morbid impressions affecting the pulmonary tissues,

vitiating the mode of their nutrition. Hence the origin and frequency of tubercles, and the gray induration of the pulmonary tissue, named, by Laennec, infiltrated tuberculous matter.

Cellular tissue, always intimately associated with lymphatic circulation, exists in the lungs, and unites the different component elements together. With the mucous tissue of the pulmonary vesicles, it forms the mass of the parenchyma of these viscera. The lungs are supplied with nerves from the eighth pair, or pneumo-gastric, and from the sympathetic, or ganglionic. The pulmonary nerves from these two sources, are, in a great measure, confounded together in plexuses, formed by the anastomosing of branches of the eighth, and of the great sympathetic. From the pulmonary plexuses thus formed, nerves are distributed to the lungs, accompanying the bronchial tubes, and appear to be lost in their mucous tissue. The first of these nerves connect the lungs with the cerebral organs, in which reside the faculties of sensation and perception; the second, we have already seen, associates different organs in sympathetic actions.

The lungs are the seat of an internal sensation, announcing to the intelligence the want of respirable air. This sensation, it is to be inferred, is imparted by the pneumo-gastric. The muscles performing respiration, are compelled, by instinctive impulses, and internal stimulations, independent of volition, to the acts requisite for respiration: the ganglionary nerves, it is to be presumed, accomplish this result. Previous to the formation of the pulmonary plexuses, by its anastomosis with branches of the ganglionic nerves, the eighth, or pneumo-gastric, sends off the superior nerves of the larynx; now the larynx has a different kind of sensibility from the bronchial mucous membrane, and impression on it do not occasion the same sympathetic actions, but those of a different order.

Such are the anatomical elements forming the structure of the lungs. This structure is arranged into lobes, lobules, and air cells or vesicles, and which are formed by the ramifications and terminations of the bronchiæ. The large primary divisions give origin to the lobes, and the smaller ramifications to the lobules. No direct communication exists between these, or between the air cells, or pulmonary vesicles, each of which has its parietes, and is kept separate from the others by cellular tissue. This circum-

stance explains the frequency of the partial affections of the pulmonary viscera. A single lobule, or a few vesicles may be separately affected, without involving other lobules or vesicles in the disease. Pulmonary apoplexy furnishes an example, and also gangrene of the lungs. In both affections, very frequently, the pulmonary structure is in the most natural state immediately adjoining that which is the seat of the disease. The same circumstance is witnessed when tubercles exist; the structure around them being often perfectly natural.

The exterior of the lungs is protected by a firm serous membrane, that nearly envelopes them, but without entering properly into the pulmonary structure; it is the *pleura.* It forms two sacs, one for each lung. These sacs adhere to and line the inside of the thorax, *(pleura costalis,)* are reflected anteriorly and posteriorly from the spine and sternum, constituting a septum, (the *mediastinum,)* and forms a covering to the external surface of the lungs, *(pleura pulmonalis.)* The inner surfaces of the pleural sacs, are, consequently, opposed to each other.

The pleura gives support to the lungs, prevents the rupture of the pulmonary vesicles in violent efforts, and the escape of the air into the pectoral cavity, and by its smooth, polished, and lubricated surface, facilitates the play of the lungs and ribs in the movements of respiration. Inflammation of the pleura, by changing the character of its secretion, by destroying its polish, and its slippery surface, and thus impeding the easy gliding of the lungs in the respiratory movements, occasion difficult respiration and embarrass the pulmonary functions.

§ 4. *Muscles of Respiration and Respiratory Nerves.*

In the respiratory apparatus we have seen provided a moveable chest, *(the thorax,)* containing the immediate organs of respiration; tubes or air conduits communicating with the external air, and conducting it into the interior of the lungs and pulmonary vesicles, presenting an extensive surface for the mutual action of the air and blood on each other. But, as the air is passive, to ensure its introduction into the lungs, and its constant renewal in the air vesicles, the provision of a means for that purpose is necessary. This operation is effected principally by muscular contraction.

The muscles, the agents of the respiratory movements, are not all equally essential, or as constantly employed in this process. They may be placed in two classes. The first are those without whose action respiration cannot be performed. Such are the diaphragm and the intercostal muscles. The diaphragm forms a moveable partition between the thorax and the abdomen. By its contraction it descends, presses before it the abdominal viscera, and enlarges the cavity of the thorax; when it relaxes, the abdominal viscera are pressed upwards by the abdominal muscles and invade the cavity of the thorax, diminishing its area. The diaphragm and abdominal muscles are in opposition to each other, or are antagonizing powers.

The intercostals consist of two lamina of muscular fibres, internal and external, filling up the interval between the ribs; their action is to elevate or depress the ribs, and thus to enlarge or diminish the pectoral cavity.

The second class of respiratory muscles are those that are adjuvant to the special muscles of respiration, and concur in that act only at particular times and under certain circumstances. When obstacles interrupt the free passage of the air into the pulmonary vesicles, or the area, or the numbers of these become very much diminished, and consequently greater or more frequent efforts than are usual, are demanded for inspiration and expiration, various muscles are brought into play for the assistance of the regular respiratory muscles. The same occurs in extreme debility, when all the forces that can be brought to bear on this function are put in requisition for its maintenance. The respiration becomes, under these circumstances, exceedingly laborious: the nostrils are dilated to their utmost extent, admitting a larger column of air, and diminishing the resistance to its passage; the mouth is extended for the same purpose; the muscles attached to the head and trunk act on this last, draw up the shoulders, scapulæ, and ribs, while the large muscles arising from the trunk and fixed in the upper extremities, also assist in elevating the chest. The abdominal muscles, and the serrati, on the other hand, lend their assistance in the expiratory exertion.

The above-described muscles are the agents of the physical actions, adapted to the physical properties of the air, and which are made subservient to the purposes of respiration. But muscu-

lar action, can be accomplished only through the agency of nervous stimulation directed on the muscular fibre; and as the muscles employed in respiration may be, and are, frequently, applied for other objects than respiration, they ought of necessity to be influenced by special nerves and nervous centres or organs, directing their actions specifically to the accomplishment of the movements in which respiration consists. Now, these muscles are supplied by different nerves having different origins, and thus present prima facie evidence of the exercise of different offices. The fact is placed beyond question by the admirable researches of Mr. Charles Bell.* From his elaborate demonstrations, it is made apparent, that the respiratory muscles receive nerves having an origin different from those of voluntary motion, or of sensation. They arise from a tract of medullary matter, in the medulla oblongata, placed between the anterior column which presides over voluntary motions, and the posterior column appropriated to sensation. This middle column, he has clearly proved, directs the motions performing respiration, and unites a great number of muscles in congenerous actions for the execution of a variety of movements connected with respiration. The nerves deriving their origin from the respiratory column of the medulla oblongata, and which may be designated as nerves of respiration, are the portio dura of the seventh pair, the glosso-pharyngeal, a part of the par vagum or pneumo-gastric, the spinal accessory of Willis, the phrenic or internal respiratory, the external thoracic or external respiratory, and hypoglossal. These nerves are superadded to those of voluntary movements, and are distributed to the muscles of the face, throat, chest, and the diaphragm, exciting their actions in the movements required for respiration, and connecting them in the actions of speaking, laughing, singing, crying, sneezing, &c. modifications of the respiratory motions.

The nervous central organs and nerves of respiration, are independent of the brain in the exercise of their functions. To this circumstance we are indebted for the continuance of respiration and consequently of life, in apoplexy, in profound sleep, and in coma; in all of which the cerebral functions are more or less suspended. The respiratory muscles may also be struck with

* Exposition of the Natural System of the Nerves, &c.

paralysis, as it respects voluntary movements, yet preserve all their mobility in the acts of respiration; and they may be inversely affected.

Injuries of the medulla oblongata and superior portion of the spinal marrow, are succeeded by instantaneous death, from the immediate suspension of respiration, by the paralysis induced in the respiratory muscles.

The respiratory motions are influenced to a certain extent by volition, in the production of speech, &c. but the will is not capable of governing them so entirely as to suspend completely their functions.

Sect. II.—*Physical Relations of Respiration.*

The atmospheric air is to the lungs what aliment is to the stomach. Its presence, in contact with the mucous tissue of the pulmonary air cells, is essential to the sustentation of vital phenomena; its absence is productive of a peculiar painful sentiment, giving rise to an instinctive want, impelling animals to the acts for its gratification.

Respiration has for its object the introduction of the air into the lungs, in which process the physical properties of the air are made to concur. The air by its elasticity and its pressure, penetrates every vacuity to which access is open, and prevents the formation of a vacuum. Respiration consists of two acts, inspiration and expiration. Inspiration is the enlargement, or dilatation of the pectoral cavity. It is accomplished by the descent of the diaphragm and the elevation of the ribs. A tendency to a vacuum is thus formed; the air in the pulmonary vesicles expands and is rarefied; and the denser external medium, having free admission by the air conduits leading into the lungs, rushes in, distends the lungs, and re-establishes the equilibrium. Inspiration is a mechanical enlargement of the cavity of the chest.

The contraction of the muscles ceases; the diaphragm relaxes; the abdominal viscera and muscles which had yielded to its action, now react and force it back upon the thorax; the ribs are pressed downwards by the elasticity of their cartilages; and the capacity of the pectoral cavity is diminished. The lungs being compressed in every direction, the air that had entered in the

expansion of the chest, is now expelled. This act constitutes expiration, and consists in a mechanical contraction of the thoracic cavity.

Reisseissen and other physiologists advance the opinion, that the lungs are not passive in respiration, following merely in their expansion and contraction the parietes of the thorax, but have an active participation in these actions. It is not improbable that the elasticity of the lungs may yield some concurrency in expiration, but it is difficult from any recognised inherent properties of the pulmonary tissue, to believe in their constant resilience in inspiration. The few facts observed of expansion of the lungs in penetrating wounds of the thorax, which are exceptions to a general rule, can be explained satisfactorily on other principles.

The capacity of the lungs has been very differently estimated by physiologists. In this respect great diversity must of necessity prevail. The size and capaciousness of the chest and lungs vary exceedingly in different individuals, and must prevent any uniform and positive result.

The quantity of air received into the lungs with each inspiration and expelled in expiration, has been valued from three to forty cubic inches; and from fifteen to twenty cubic inches, it is now generally admitted, are the quantity of ordinary inspiration and expiration. But the lungs are not emptied at each expiration; they continue expanded with air, and still occupy the whole cavity of the thorax. By forcible efforts, after an ordinary expiration, an additional quantity of air can be expelled, which Bostock estimates at one hundred and seventy cubic inches, and yet there will remain in the lungs one hundred and twenty cubic inches; so that by this calculation, the lungs in a quiescent state are supposed to contain two hundred and ninety cubic inches of air. In the act of inspiration, it has been seen, twenty additional cubic inches are introduced into the lungs; which will give consequently three hundred and ten cubic inches as the capacity of the lungs in their distended state.

From this valuation of the capacity of the lungs, it is evident that only a small amount of the quantity of air contained in them, is changed in ordinary respiration, by each inspiration and expiration. After expiration, there will remain nearly three hundred cubic inches in the pulmonary vesicles. The air inhaled with

each inspiration, it is inferrible, does not, then, immediately act on the blood and part with its oxygen, but is mixed with the air remaining in the pulmonary cells, and gradually penetrates into the interior pulmonary vesicles by a species of circulation or intestine movement. This circulation of the air contained in the pulmonary vesicles, and the mode of its accomplishment, have not attracted the particular attention of physiologists; yet it is a subject of interest, and is connected with the production of important phenomena.

The physical properties of the air are made subservient to the performance of this process, and it presents an instance of the employment by nature of physical actions in the functions of the animal economy. Respiration, in fact, consists of a combination of physical, chemical, and vital operations.

The manner in which the air in the lungs is changed, results from the difference in the temperature and density of the inspired volume of air, and that contained in the pulmonary vesicles. In warm blooded animals the heat imparted by the blood to this last, elevates its temperature, rarefies, expands, and disposes it to escape externally. But the parietes of the pulmonary vesicles are resisting forces, and it is necessarily propelled through the bronchial tubes communicating with the vesicles. The volume of air inspired is of a lower temperature and denser. This, together with the general atmospheric pressure, imparts to it a constant tendency to displace the lighter rarefied air of the vesicles, and to prevent the vacuum forming in the lungs, by the expansion of the chest. Two currents are, in this way, established in the lungs: the one consisting of the volumes of air successively inspired, moving towards the interior; and the other, of the volumes to be successively expired moving towards the exterior.

This operation, simple as it appears, is connected intimately with, and is productive of, numerous phenomena, physiological and pathological. It furnishes the explanation of the influence the temperature and density of the atmosphere exercise over respiration. It is well known that a low temperature and dense atmosphere are highly favourable to respiration; it is, then, performed with ease; is slow, full, and deep; the organic functions are invigorated, and the muscular system enjoys great force and activity.

A high temperature and rarefied atmosphere, on the contrary, are unfavourable to respiration; it is oppressed and laboured; is hurried and short; the organic functions are more or less deranged, and the muscular system is enfeebled and incapable of prolonged efforts.

In an atmosphere of low temperature, or maximum of density, oxygen is consumed in largest quantity, and a proportional amount of carbonic acid gas is formed. The arterial blood acquires at the same time its most vivid hue, and the venous blood possesses its darkest colour.

In an atmosphere of elevated temperature, the consumption of oxygen is proportionally diminished, and less carbonic acid is exhaled; the hue of the arterial blood is less brilliant, and that of the venous blood less sombre.

These varying circumstances proceed from the differences in the velocity of the currents, or in the circulation of the pulmonary air. When the atmosphere is of low temperature and dense, it rapidly penetrates into the interior, and the contained air as rapidly escapes. The respiratory process is, then, more perfect. But when the temperature and density of the external medium approach to that within the lungs, an equilibrium is established between them, and the currents changing the air contained in the pulmonary vesicles, are very feeble or no longer exist. The change of the pulmonary air is then effected solely by the mechanical action of the parietes of the thorax.

That the air contained in the lungs is changed in the manner indicated, in the respiration of warm blooded animals, appears to be confirmed by the mechanism and process of respiration in cold blooded animals. Their temperature being the same as that of the exterior medium, the means we have considered as completing the respiration of warm blooded animals, by creating currents in the air of the lungs, could not be applicable to them, and some other process must be brought into operation. Accordingly, we find the air is introduced, and forced into their lungs, when they possess these viscera, by a species of deglutition, accomplished by muscles provided for that purpose.

Other additional and interesting relations with physiological and pathological phenomena, grow out of the principle, I have endeavoured to show, prevails in the respiratory process, produc-

ing the circulation changing the air included in the pulmonary vesicles. In extremely hot weather, and in tropical climates, muscular efforts are feeble, occasion speedily lassitude and fatigue, and cannot be persisted in for any length of time, without incurring the risk of serious disorders in the functions. These effects proceed from the imperfect performance of respiration, and the consequent defective decarbonization of the blood, and which are caused by the equilibrium in the temperature of the external air, and that of the lungs, diminishing, or nearly suspending the circulating currents of the air introduced into the pulmonary organs. Under these circumstances, severe, prolonged exercise, or violent muscular exertions, may even occasion death from asphyxia. At the battle of Monmouth, in the revolutionary war, June 28th, 1778, an excessively hot day, a number of soldiers perished from the effects of the extreme heat, and their exertions: they were found dead on the field, without a wound having been received. Most of the sudden deaths during extreme heats, amongst the labourers in our cities, attributed to drinking cold water, are produced in this manner.

In pathology, this principle explains some well-recognised phenomena. Hepatic diseases, and bilious disorders, are well known to be the prevailing affections of hot seasons, and intertropical regions. It has been shown, that under those conditions respiration is inefficiently performed, and the blood is not properly decarbonized by this process. But as this result must be accomplished for the maintenance of healthy actions, a compensation for this defect must be provided, to guard against this common source of danger. The liver is the organ whose office, in this respect, is in part, at least, congenerous with that of the lungs; and the secretion of bile is the means effecting this object. Hence the increased activity of this viscus, and the profuse secretion of bile in warm climates and seasons, and the consequent frequency of hepatic and biliary disorders.

In hot climates, fevers generally assume a malignant aspect, and are very rapid in their course. These characters they probably derive from the imperfect, or extremely diminished decarbonization of the blood, from the suspended action of the liver; while, from the elevated temperature of the atmosphere, respiration is not capable of itself of completing this process. Hence

the tendency of the blood to what is called its dissolved or putrid state, in which it loses its coagulability, and presents its darkest hue: and to this cause may be due the hæmorrhagic effusion of black grumous blood from the mucous membrane of the stomach, bowels, mouth, &c. so frequent in those fevers.

The explanation that has been given of the principle accomplishing the change the air contained in the pulmonary vesicles undergoes, during respiration, and acting in the manner described, appears to me the only one consistent with established phenomena, and adequate to effect it. It is simple, but this is in union with the operations of nature generally; and, though simple in itself, the consequences depending on it, are seen to be of the most important character.

The volume of air inhaled in each inspiration, is not immediately employed in respiration; it does not, as soon as arrived in the lungs, lose its oxygen, and become charged with carbonic acid. These changes occur only when it has reached, and been diffused through the pulmonary vesicles. A certain amount of air is thus kept in reserve for the purpose of respiration, capable of supplying this want for a few moments. Without this provision, the attention would be incessantly required for respiration; anhelation would constantly occur on the slightest efforts, as in individuals whose lungs have been reduced in their capacity by disease, and we should have been disabled for useful exertions.

Trivial as this circumstance may appear, it is pregnant with most important results, involving the well-being, the existence, and the exercise of the physical and moral endowments of man. Without the provision in the lungs of this excess of air beyond the immediate demand of respiration, prolonged speech, the communication of the thoughts and sentiments in harangues, would be impossible, and eloquence, the most effective of the means of influencing human actions, by exciting the passions, or persuading the understanding, could have no existence. The modulation of the voice in song, a source of pure and exquisitely pleasurable sensations, would have been equally unknown, and the vocal communications of our race must have been limited to simple colloquy, embracing the mere wants of existence.

The influence of this provision has a still further extent. The capability of our physical efforts depends on this arrangement. It

is always proportionate to the size of the chest, and to the capacity of the lungs. In every violent muscular exertion, the trunk becomes a point d'appui, sustaining the efforts that are made. A full inspiration is taken, the chest is expanded, and then remains fixed; the diaphragm is firmly and immoveably contracted, antagonizing the contractions of the abdominal muscles; and the glottis is closed, preventing the expulsion of the air from the lungs. Respiration is thus suspended momentarily during the period of strenuous effort; and violent muscular exertions must, consequently, consist always of successive efforts. The power of continuing these efforts, or what is called *wind*, depends on the capacity of the lungs, and the amount of surplus air contained in them beyond the immediate necessity of respiration. The consumption of the surplus stock of air in the lungs during the suspension of respiration, causes the hurried breathing succeeding on prolonged muscular efforts; persons, it is then said, are *out of breath.* The exhaustment of the respirable air is by this means speedily compensated.

The diminution of the capacity of the lungs by disease, as in hydrothorax, bronchitis, phthisis, &c. never fails to disable the individual from all active exercises, or muscular exertions: he is anhelose from the slightest efforts, and is condemned to a state of repose. In these cases the lungs contain no more air, very frequently, than is adequate for instant respiration, and which cannot be spared for other purposes. Even speech is often difficult from this cause in very bad cases.

Sect. III.—*Mechanical Effects Resulting from the Respiratory Acts.*

In the animal economy, vital, chemical, and physical actions are frequently combined; and each is employed according as it may be appropriate to the production and maintenance of particular phenomena. Respiration presents an example of this combination. The mechanical actions attached to respiration are not restricted to this function alone, but extend their influence to other functions and organs, and are concerned in the production of particular phenomena, both of the physiological and pathological state, which cannot be properly understood without the appreciation of the full extent of their operation.

When the lungs expand in the act of inspiration, their capacity enlarges, the compression exercised on them is removed, and, consequently, the resistance to the passage of the column of venous blood into the lungs, from the right heart, through the pulmonary artery, is diminished. The blood passes with greater velocity, and the ventricle is entirely emptied with each contraction. Inspiration in this manner expedites the movement of the column of blood, returning from all the organs of the economy through the heart, increases the velocity of the venous circulation, and facilitates the evacuation of the capillaries of the viscera.

The expansion of the chest in inspiration is thus an active force in conducting the circulation. It creates a tendency to the formation of a vacuum, and, consequently, gives a disposition to all the fluids communicating with the lungs to be drawn, or to rush into them. This phenomenon is demonstrated by the experiments of Dr. Barry.

Expiration, on the contrary, being accomplished by a compression of the lungs, and attended with a diminution of their capacity, opposes a resistance to the column of venous blood passing from the right heart into the lungs. The blood escapes with more difficulty from the ventricle, which, in forced expiration, cannot expel its contents, and empty itself by its contraction. The escape of the blood from the auricle is of course arrested, and a remora is offered to the venous circulation, which is felt in the interior of the viscera, impeding their circulation, and the emptying of their capillary vessels.

The influence of respiration over the circulation is thus seen to be very extensive; and, though proceeding entirely from a physical operation, concurs very efficiently in the exercise of this function.

It is extended also, by this means, to all the important organs which are modified by the condition of the respiratory organs, and the performance of this function. The degree of this influence is very perceptible in the brain. When this organ is exposed by a removal of a portion of the cranium, or the hand is placed on one of the fontanelles of an infant, an alternate elevation and depression are perceptible in the brain, perfectly synchronous with expiration and inspiration. This motion of the

brain proceeds from the sudden arrest of the blood in its course through the veins, caused by the compression of the lungs in expiration, opposing its afflux into them from the heart; and the sudden increase of its velocity, by which the veins are rapidly emptied, produced by the rush of blood into the lungs when expanded in inspiration. The accumulation of the venous blood in the brain, and the turgidity and swelling of the veins following on expiration, occasion the sudden distention or elevation of the cerebral structure, which, from its elasticity, contracts on itself when the distending power is withdrawn.

The brain, from the large amount of its circulating fluid, the size and number of its veins, and its vicinity to the heart, manifests, in a striking manner, the physical effects of respiration on the circulation. Other organs, especially the liver, experience doubtless similar effects, though they are less obvious.

The swelling of the jugular veins in the neck, and the sanguine suffusion of the face in forced and prolonged expirations, are a result and an evidence, at the same time, of the retardation the blood experiences in the veins from that act.

Forcible efforts are attended with a physical action on the circulation, of considerable power and extent. They arrest almost entirely the course of the blood through the lungs, and give rise to numerous phenomena. When strong exertions are made, the lungs are distended by an inspiration, as has been explained; the air is prevented from escaping by the occlusion of the glottis; and at the same time the expiratory muscles contract with energy and powerfully compress the lungs. The air contained in the bronchial tubes and pulmonary vesicles cannot escape; it yields partially from its elasticity to the compression it experiences, but reacts on the mucous tissue in which the blood circulates, and on the capillary and pulmonary vessels, subjecting them to an equal compression. The consequence of this action is to propel the blood, about entering the pulmonary veins, with rapidity through them towards the heart, and to prevent any additional quantity arriving from the heart. The blood is thus driven back upon, and accumulated in the heart, on the side of the lungs, while, from the contractions of the muscles, it is propelled with increased velocity towards the heart, from the extremities. The right cavities often suffer from this extreme distention; they yield

to it, and enlargement of the right auricle, or ventricle, and sometimes of both are occasioned by frequently repeated muscular efforts of great violence, or too long sustained.

Should it happen that the lungs are more than usually congested with blood from an existing irritation in them, and the heart is at the same time acting with force, urging the blood into the pulmonary tissues, the compression experienced by the mucous tissue from the contained air, may occasion a forcible exudation of the blood from it, and give rise to an attack of hæmoptysis.

The extent to which the circulation is effected in muscular exertions, is the cause of the injury every kind of exercise and exertion is found to occasion in the acute inflammations of the important viscera.

The abdominal viscera are subjected to a species of oscillatory movement, by the alternate descent and rise of the diaphragm. This action becomes painful, and excitative of injurious effects, when they are acutely inflamed, as also in the inflammation of the peritoneum. All exertions are, then, impossible, or aggravate the intensity of the disease. To obviate this effect, respiration in those affections is performed chiefly by the ribs; nature, by an instinctive operation, arresting the action of the diaphragm.

A mechanical relation of a different nature is attached to the respiratory organs, and often affects deeply the exercise of their function. The lungs, as it respects their vesicular structure, may be regarded as a great reservoir of air; and as respects their vascular structure, and tissue, permeable to the circulating fluids, as a vast reservoir of the sanguine humour. They are placed, on the one part, under the influence of the muscular powers of respiration; and on the other, are subjected to the forces moving the fluids in the tissues. It has been shown already, in what manner the air included in the pulmonary vesicles, when acted on powerfully by the expiratory muscles, arrests the circulation by its physical compression. An opposite condition frequently prevails. The blood is accumulated in the lungs, under the influence of irritation, or other causes, in so large a quantity, as to compress the pulmonary vesicles, and prevent the admission of air into them. The area of the lungs, fitted for the purposes of respiration, is in this way often reduced one-half, and sometimes even two-thirds,

and all the functions are deranged from the impairment of the respiratory function.

The mucous tissue of the smaller bronchi is often the seat of a sanguine congestion produced by irritation; it becomes turgid and thickened by the augmented quantity of blood invited into it, and their caliber is obstructed. The passage of the air through them into the pulmonary vesicles is thus prevented, and the respiration becomes excessively embarrassed. This condition constitutes one of the forms of asthma.

The disorder of the function of respiration in these cases, arises altogether from the mechanical difficulty to the admission of the air into the pulmonary vesicles, produced by an excessive accumulation of blood, either in the pulmonary capillaries, or the mucous tissue.

Sect. IV.—*Chemico-Vital Phenomena of Respiration.*

The function of respiration consists in a reciprocal action between the air inspired into the lungs, and the fluids of venous, chylous, and lymphatic absorption. This action is principally chemical, but some of the phenomena attending it cannot be explained on the common principles of chemistry, and belong to the recondite, unknown action of vital laws. The changes occurring in these fluids can be described and understood in a clearer manner by treating them separately.

§ 1. *Phenomena Manifested by the Air.*

The air inspired into the lungs, consists of 79 parts nitrogen, and 21 parts oxygen; it is cool, dry, and dense. The air expired, contains no oxygen, but its place is supplied by carbonic acid; it is warm, loaded with vapour, and rarefied.

The most important of these phenomena, and in which respiration consists, is the disappearance of oxygen from the air inspired, and the appearance of carbonic acid in the air expired.

Chemists have endeavoured to determine the exact quantity of oxygen consumed, and of carbonic acid produced in respiration. The attempt to arrive at a fixed result is nugatory. It must vary in every individual, and in the same individual at different periods. The estimates have varied from 39,534 cubic inches, (Allen and Pepys,) to 51,840 cubic inches, (Menzies,) of oxygen gas

consumed in twenty-four hours; or from 13,343 grains to 17,496 grains.

The quantity of carbonic acid produced fluctuates very considerably. It is, in the greater number of instances, less than the amount of oxygen that disappears, or that would be required to form the quantity of carbonic acid produced. Taking 45,000 cubic inches, as the average of oxygen consumed in twenty-four hours, and weighing 15,500 grains, the carbonic acid formed in the same time will be 40,000 cubic inches, weighing 18,600 grains. The proportionals of this sum of carbonic acid, are 5,208 grains of carbon, and 13,392 grains of oxygen, or 2,100 grains less of oxygen than what has disappeared.

The manner in which the oxygen disappears, and the carbonic acid is formed, is not known with certainty. The chemists have generally conjectured, that the oxygen united in the lungs to carbon, ejected from the blood, and thus gave being to the carbonic acid. When it was believed, that the quantity of oxygen consumed in respiration, was exactly equivalent to the formation of the carbonic acid contained in the air expired, this opinion appeared firmly established. More accurate experiments have shown the fallacy of that statement; and it is now known that more oxygen is consumed than is required for the production of the carbonic acid appearing in the air of expiration.

If the loss of the oxygen in the inspired air, is not to be accounted for by its combination with carbon for the formation of carbonic acid, it must be absorbed by the blood. Positive experiment has not demonstrated the presence of oxygen in the blood of the pulmonary veins, or arterial blood, yet, that it is contained in that blood may be rendered very conclusive.

A general law in nature is invariable in its principle; though the means of its application are immensely diversified. The action of oxygen on the nutritive humours is a law of this kind, and is essential to the existence of vital phenomena. No exception exists to this law. Now the fœtus of the viviparous animals has no direct communication with the atmosphere. It derives its oxygen indirectly from the mother, its blood in the placenta being brought nearly in contact with the maternal blood in the uterus. The two are separated only by delicate membranes. Oxygen must, consequently, exist in the maternal blood, or the

fœtal blood could not be arterialized by it in the placenta. The placenta is the respiratory organ of the fœtus, and is analogous to the bronchiæ in the larvæ of the Batrachiæ, which derive their oxygen from water, but have a pulmonary or ærial respiration, when developed into the perfect animal.

From another well-established fact, the presence of oxygen in the blood is demonstrated. The swim bladder of fish contains oxygen, sometimes in great purity; and in some fish, it is furnished with an air-duct, evacuating the air excreted into it. The oxygen is here furnished by the blood, and must be derived from respiration.

The carbonic acid eliminated in respiration is an excretion from the blood. This proposition must follow on the preceding, for if the oxygen be not consumed in the lungs by the formation of carbonic acid, this must be discharged from the blood. The old doctrine of La Grange, that oxygen is absorbed by the blood, and the carbonic acid is eliminated from it in respiration, and which had been abandoned for the theories of later chemists, appears to be the most accordant to the actual phenomena of respiration.

The sums of oxygen consumed, and of carbonic acid elicited, are not the same at all periods of the twenty-four hours: the maximum is between 11 A. M. and 1 P. M. and its minimum from 9 P. M. till about 4 A. M. The quantity of carbonic acid emitted is also affected by various causes. It is very considerably diminished by alcohol, mercury, and nitric acid.

The part that the nitrogen of the atmosphere performs in respiration, is not clearly ascertained. Most commonly it is supposed to be entirely passive, and, that after parting with the oxygen, it is expelled. Late experiments have, however, proved that the whole of the nitrogen is not always returned from the lungs; and it is further satisfactorily demonstrated, to be exhaled from the blood.

The conclusion of Sir Humphrey Davy, from his researches on this subject, that the whole of the atmospheric air inhaled is absorbed, and the surplus quantity beyond the wants of the economy is discharged, appears to be the most rational and the best sustained by the facts positively ascertained.

In what state is the air after its absorption in the blood, and the carbonic acid gas before its elimination? are they free, or are

they in combination? The testimony of observers as to the facts on which this question is to be resolved, is not consistent. The presence of air in the blood is asserted by numerous and imposing authorities, among whom are Hales and Haller. M. Krimmer states that the air in the aorta, included between two ligatures, contained oxygen, hydrogen, and carbonic acid. Vogel asserts that he ascertained, when blood was placed under the receiver of an air-pump, that carbonic acid gas escaped from it. Sir Everard Home and Mr. Brande repeated the same experiment, and with the same result. The proportion they obtained, was two cubic inches of the gas for every ounce of blood. Opposed to this testimony is that of Dr. John Davy, who declares that he has not been able to discover any disengagement of air from blood subjected to the air-pump. He further asserts that he has added carbonic acid to blood and to serum, in the proportion of a fourth of a cubic inch to the ounce, that it has been completely absorbed by those liquids, and yet, when they were made to coagulate at a temperature of 200°, Fahr. no gas was disengaged. Dr. Staples, of this city, at my request, did me the favour to repeat the examination of blood, immediately after it was drawn from a vein, with the air-pump. The result corresponded with the observations of Dr. Davy. No air was extricated.

Other gases besides the components of the atmosphere, when introduced into the lungs are absorbed into the blood. Thus hydrogen mixed with oxygen, to form a factitious atmosphere is found to be absorbed. The same occurs with nitrous oxide, and which thus produces its intoxicating effects. The vapour of sulphuric ether, when inhaled in the same mode, displays in a few seconds its action on the brain. It is most probable that many other matters assuming the state of vapour, may be introduced in this way into the system.

The most probable inference, at least until the facts are more decidedly verified, is, that the air when absorbed enters into combination with the blood; and the oxygen and azote are disengaged in the intimate structure, as they may be required for the wants of the organism, by the forces that govern the molecular actions of the nutritive and secretory functions. The carbonic acid is in like manner combined with the blood, which receives it in the intimate structure, when it is disengaged in the same molecular

actions, incessantly changing every tissue of the organism. Let it be remembered, however, that this view embraces only an opinion, and is not a statement of phenomena, a knowledge of which alone constitutes science. The phenomena are yet unknown.

Should this view be sustained by further observations, and the combination of the atmospheric air and carbonic acid with the blood be completely established, the mucous tissue of the bronchiæ, it will be readily admitted, partakes actively in the process. It may even now be regarded as performing for respiration, a part somewhat analogous to that of the gastro-intestinal mucous tissue, in the digestive processes. The absorption of the air is influenced to a considerable extent by the condition of the bronchial mucous membrane, and the elimination of the carbonic acid being entirely an excretory process, is a part of the function it executes.

The vapour that appears in the air of respiration, is an exhalation or excretion from the bronchial mucous membrane. It consists of the watery portion of the blood, often impregnated with volatile and odorous principles that have been introduced into the economy. It possesses considerable analogy with the perspiration; like that fluid, its usual state is insensible vapour, but under certain circumstances, is poured out in considerable quantity, forming œdema of the lungs, and even causing suffocation.

The bronchial mucous membrane by its exhalent function, appears to exercise a depuratory office. Numerous foreign substances introduced into the blood, are eliminated through this route, especially those of a volatile nature. Garlic, camphor, musk, assafœtida, and other odorous matters, can be perceived in the breath for several hours after they have been taken. Magendie injected into the veins of an animal phosphorated oil; the phosphorus exhaled from the lungs inflamed by the contact of the air, and the animal expired flame. It is most probable that many expectorants excite the bronchial secretion, from being rejected from the economy through this surface.

§ 2. *Phenomena Manifested by the Blood in Respiration.*

The blood consisting of the humours of venous, chylous, and lymphatic absorption, mingled together in the right cavities of the heart, passes into the lungs through the pulmonary artery of a deep Modena red, or dark purple. Exposed to the influence of

the atmospheric air, this colour is changed into a bright scarlet or vermilion, which is preserved in the passage of the blood through the pulmonary veins, the left cavities of the heart, and the arteries, until it arrives in the intimate structure of the organs of the economy. This vermilion hue, the characteristic of arterial blood, is lost during the processes of nutrition, and of the organic actions, for which arterial or oxygenized blood, is alone adapted. These actions cease, and life becomes immediately extinct, in the higher animals, in all the organs into which blood of a black colour, or unoxygenized by respiration penetrates.

The change of colour experienced by the blood in the process of respiration, or its conversion from venous into arterial blood, is the most obvious, and the one chiefly appreciable by observation. This change is, however, limited exclusively to the colouring matter of the red globules. But, it is not to be presumed that this is the only element of the blood that undergoes a modification. Many animals are devoid of red blood, yet oxygen is as requisite to perfect their sanguine or nutritive humour, as it is to the preparation of coloured blood.

The formation of arterial blood, or the proper nutritive fluid, is the object accomplished by respiration, and is the completion of those transformations the nutritive elements of the aliment undergo, before they are capable of becoming organized and of manifesting vital phenomena. The changes experienced by venous blood, in its conversion into arterial blood by respiration, are simultaneous with the alterations effected in the air inspired into the lungs, and which have already been described. The venous blood loses carbon and watery vapour, which are imparted to the air expired, and the arterial blood obtains oxygen, which disappears from the air inspired.

In the chemical doctrine of respiration, the elimination of carbon was assigned as the only change the blood experienced; and the oxygen served no other object than to facilitate this operation, by combining with the carbon in the lungs. This opinion still continues to be advocated.

In treating of the changes sustained by the air in respiration, it has been shown that more oxygen is consumed than is required for the formation of the carbonic acid generated. If the elimination of carbon alone from the blood was the only object of respi-

ration, in the immense variety of means by which nature accomplishes her designs, we might expect to find some one instance, where this result was obtained without the aid of oxygen, as carbon could be rejected in many other modes, than by its combination with oxygen. The formation of bile presents an instance of the decarbonization of the blood in another manner, and which is in part adjuvant to the lungs in this office. But, amidst all the infinity of living beings, and the endless diversity of vital phenomena, not an example can be adduced in which the absorption of oxygen is not indispensable to existence, or life is maintained by a simple decarbonization of the blood, or nutritive humour. Oxygen, it is to be presumed, sustains a more important and immediate agency, in the production of vital phenomena, than merely as the agent for separating carbon from the blood.

What properties the blood acquires in respiration, so essential to the maintenance of vital phenomena, or in what manner they act in the production of those phenomena, are questions it is not in the reach of our science to resolve. Facts are wanting to justify any positive conclusions, and observations and experiments are so little applicable with our present means, as to fail us in this research. John Hunter appears to suppose he has explained this question, by asserting, that "breathing seems to render life to the blood, and the blood continues it in every part of the body." But, when this explanation is reduced to its true value, it is no more than the simple truism, that respiration is necessary to life.

An uninterrupted affluence of arterial, or oxygenized blood, into the capillary system, and intimate structure of the organs, is an absolute condition of vitality in all the higher animals. In the lower animals, the dependance is not less absolute, though not as immediate. When this supply is arrested, or venous, or black blood penetrates the capillary system, and intimate structure, the molecular movements, the proximate cause of vital phenomena, instantly are arrested. Now, the nutritive elements introduced with the aliment, destitute of vital activity, and which we have traced in their course through the digestive apparatus into the circulating system, acquire their organization by those molecular actions, and receive their susceptibility to manifest vital phenomena: that is, they are endowed with the power we have desig-

nated irritability. That oxygen is essential to the completion of the metamorphoses of the nutritive principles from dead, into living matter, and the development of irritability, is a very probable conjecture; but it cannot be affirmed with positiveness, for it is not susceptible of demonstration by experiment.

Goodwyn supposed the suspension of respiration proved fatal from the incapacity of black blood to stimulate the heart, the contractions of which ceased when it no longer received arterial blood. Bichat has shown this supposition to have been erroneous. The cessation of the action of the heart proceeds from the loss of its capacity to be stimulated, from the suspension of its interior molecular movements, when black blood has penetrated into its intimate structure through the coronary arteries. The heart, then, dies, as all the other organs die, when they receive black, in the place of arterial blood. Until this state has actually occurred, the heart continues to contract under the stimulation of black, as well as by that of red blood.

The influence of arterial blood in maintaining vital phenomena, can be explained in no other mode, than the one or the other hypothesis: either its agency in the production of vital susceptibility or irritability; or the necessity of its excitation to the maintenance of the organic actions.

As venous blood is equally capable with arterial to stimulate the heart, and provoke its contractions, it is not probable, that its arrival in the capillaries, and intimate structure of the tissues, proves so instantaneously destructive, simply from its inferior stimulant properties. Besides, it would be easy to compensate this diminished excitation, by exterior, or artificial excitement; but it is well known, that when arterial blood is not received into the capillaries, no excitement, however powerful, is capable of producing the slightest impression. Every examination therefore tends to increase the probability, that the presence of oxygen in the blood is an indispensable requisite to the development of irritability, or the assumption of the capacity for vital phenomena by the nutritive principles in the act of becoming organized.

The nervous system is supposed, very generally, to exert some immediate agency in accomplishing the changes experienced by the blood in respiration. In what this agency consists, is not clearly expressed; but, as far as can be collected from the vague

expressions in which it is described, it appears to be regarded as the operative power producing the mutual action of the air and blood on each other.

When the facts are closely interrogated, they do not sustain this conclusion so positively as to justify its admission as an axiom. It is founded on the well-known experiment of the division of the eighth pair of nerves, or par vagum. When the inference was first made, it certainly was drawn from erroneous data. The facts were not understood. The division was effected so high, as to involve the laryngeal nerves. The muscles of the glottis were paralyzed, and the animal was suffocated from an incapacity to expire. Since the recognition of this fact, the division has been made lower in the neck, or an opening has been made in the trachea, so as to admit the continuance of respiration. The animal, then, survives a longer period. Life has continued from one to twelve days, and Begin asserts, he has seen a dog live a month after the excision of an inch of both pneumogastric nerves.

When this experiment is performed, according to Professor Mayer, the number of inspirations and expirations diminish sometimes one-half, and even one-sixth, while the pulsations of the heart remain natural, or are increased in frequency.*

After death from this experiment, the lungs are often found to be congested with blood, and the bronchial tubes to be filled with a sero-mucous fluid. A circumstance observed by Mayer sometimes occurs, and occasions a very prompt suffocation. It is the entrance of the food which has been rejected by the stomach into the glottis, and even into the bronchial tubes, in the mucous membrane of which it excites inflammation, causing effusions. Mayer also found the blood in the heart and pulmonary vessels was always coagulated firmly, and when the animal survived the operation some time, the coagula were white and very dense.†

The effect exhibited in the blood, by this experiment, is variously stated. Dupuytren, Magendie, and Legallois, assert that the usual change of the blood in respiration ceases to occur, and that it escapes from the arteries dark or venous blood. Dumas and Blainville attest the contrary of this assertion; and Mr. Brodie found that when respiration is artificially maintained, in a de-

* Journal des Progrès, tom. iii. p. 87. † Ibid, p. 86.

capitated animal, arterial blood is projected from the arteries. It is most probable some of the causes obstructing the passage of the air into the lungs, or preventing the immediate action of the air on the blood, and which was overlooked, was the true cause of the dark colour of the blood in the arteries, as related by the first named observers.

The conclusion inferred from this experiment, that nervous influence was essential to hæmatosis, or the accomplishment of the action of the air and blood, in respiration, is not authorized by the phenomena attending it, more correctly ascertained by additional observations. The immediate cause of death is suffocation, which appears to be induced in various manners. 1st. It proceeds in some instances from paralysis of the glottis. 2d. It has followed from obstruction of the glottis by the food regurgitating from the stomach, and being drawn into the larynx in inspiration. 3d. It is most commonly the consequence of inflammation of the bronchi, and effusions into them, obstructing the passage of the air into the air vesicles, and preventing, by a physical impediment, the due performance of hæmatosis.

The immediate cause of the congestion of blood, and collection of mucus in the bronchi, in this experiment, cannot be positively explained. All the attending circumstances have not been observed with sufficient accuracy, and detailed with the precision necessary to connect and arrange the phenomena. The sensibility of the bronchial mucous tissue, the seat of the sense of want of breath, by which the consciousness is warned of defective respiration, and called upon to excite the movements necessary for its relief, must be very seriously impaired. The irritation produced by the accumulation of mucus in the bronchi is not perceived, and the movements performing expectoration are of course not provoked for its expulsion. The muscular fibres of the bronchi, which doubtless assist in propelling the mucus along the bronchial tubes, especially the smaller ones, must be likewise paralyzed, disposing also to the accumulation of mucus in the lungs. But the irritation excited in this manner, tends to increase the secretion, and thus to augment the obstruction of the bronchi. Hæmatosis consequently is rendered imperfect, the decarbonization and oxygenation of the blood gradually cease, and the circulating fluid finally enters the arteries in its venous state. Death

then ensues from the presence of venous or dark blood in all the organs, whose functions can no longer be maintained. The examination of the blood in the arteries, during the progress of this experiment, when the animal does not perish suddenly from obstruction of the glottis, proves this gradual change really to occur; and there is every reason to believe it will be found to correspond precisely with the rapidity and extent of the effusion into the bronchi and air vesicles. Thus, the loss of sensibility in the bronchial mucous membrane, occasions an accumulation of mucus in the bronchial tubes, blocking up their caliber, and preventing the action of air on the blood; and the blood undecarbonized and unoxygenated, passing to the brain, diminishes still further the sensibility, and confirms the fatal result. The immediate cause of death in this experiment, when it does not arise from paralysis and obstruction of the glottis, is the same as occurs in acute bronchitis, pneumonia, and œdema of the lungs—a suspension of respiration and hæmatosis, from a mechanical obstruction of the bronchial tubes and pulmonary air vesicles.

In the change of the blood from the venous to the arterial state, its capacity for heat is increased. According to Crawford, the proportion between them, is as 114.5 to 100. Dr. Davy states the relative difference at 913 to 903. The increased capacity of arterial blood may be explained by the loss of carbon or the absorption of oxygen, or by both combined.

The blood also acquires an increase of temperature, or of sensible heat in respiration, though it is not considerable. From the experiments most to be relied on, it would appear the blood in the left cavities of the heart, is from 1° to 2° F. higher temperature than in the right cavities.

The preceding are the facts observed in the blood, connected with respiration. Others doubless occur, but are too obscure to be detected. These phenomena constitute hæmatosis, or the formation of the sanguine nutritive humour, destined to support the vital actions, and to maintain the nutritive and secretory functions. The accomplishment of hæmatosis is the object of the respiratory function, and is the last in the series of changes the nutritive principles are subjected to, in their transition from the dead to the living state, preparing them to perform their part in organized structure. The nutritive elements, which it is not a violent conjecture

to suppose are organic atoms, are introduced into the digestive apparatus dead matter; they pass through the different operations already detailed, and being converted into the sanguine nutritive humour, assume, by the act of nutrition, vital properties; that is, they are endowed with irritability, or the capacity to react on the impression of stimuli. Now the capacity or disposition to acquire this property, is conferred by the function of respiration. It is by no means improbable that this result is connected with the action of oxygen absorbed into the blood; but of this fact it is not in the power of any known means of research to afford positive evidence. It is an inference circumstances vindicate. An atmosphere, for instance, destitute of its due degree of oxygen, from impure exhalations, or the excessive crowding of a number of individuals in a confined space, becomes highly deleterious, creating disease of a fatal tendency. Defective hæmatosis is produced, the nutritive elements are not prepared for the purpose of vitality, nutrition is suspended, the vital phenomena are impaired, and the structure assumes a strong disposition to decomposition.

The interruption of hæmatosis, produced either by the suspension of respiration in any mode, or a deficiency of oxygen in the respired air, produces asphyxia or a suspension of consciousness, sensibility, and an obvious diminution of irritability. If this state be not very speedily remedied, death ensues, in consequence of venous blood penetrating into the brain, heart, and other organs, and the consequent extinguishment of the irritability of the organs essential to life.

Sect. V.—*Pathological Conditions of the Function of Respiration.*

A function depending on the performance of so complicated an apparatus, and the concurrence of so many organs, must necessarily be exposed to suffer derangement from numerous causes. The function of respiration may be placed in a pathological state, or morbidly deranged, by any of the following causes. 1st. Obstruction of the air passages transmitting the air into the interior of the lungs. 2d. A morbid condition of the nervous apparatus of respiration, affecting the movements of the respiratory mus-

cles. 3d. Disorder or irregularity in the circulation or its apparatus. 4th. Pathological states of the bronchial mucous membrane and bronchial tubes. 5th. Pathological states of the parenchymatous structure of the lungs. 6th. Pathological states of the pleuræ or envelope of the lungs and lining membrane of the thorax. 7th. The properties of the atmosphere, or the medium of respiration.

§ 1. *Obstruction of the Air Passages.*

Obstruction of the air passages occurs in a variety of modes. The accidental introduction into them of different solid substances, has frequently proved a cause of asphyxia. They are to be removed by surgical operations. The trachea may be so much compressed by food or other matter lodged in the œsophagus, as to embarrass very seriously the respiratory process; asphyxia has in some instances proceeded from this cause.

Suppuration occurring beneath the fascia cervicalis, and diffused through the cellular tissue of the neck, may occasion a compression of the trachea, impeding respiration. A fatal instance of this kind, occurred in the practice of the late Professor Wistar. An abscess between the trachea and œsophagus, has also been the cause of a fatal obstruction of the trachea.*

The most common cause of obstructions in the air passages, proceeds from the effects of irritation developed in the mucous membrane by which they are covered. The tumefaction of this membrane resulting from its inflammation and congestion, or from suppuration, filling up the fauces, and extending to the glottis and larynx, rendering them impervious to the air, is the principal cause of the danger attending the anginose affections.

In individuals highly characterized by the lymphatic temperament, or who possess the leucophlegmatic diathesis, irritation of the laryngeal and pharyngeal mucous membrane, has a strong tendency to the production of sero-lymphatic effusion into that tissue, producing an œdematous state of it. When this occurs at the glottis, the rima is blocked up, and suffocation rapidly ensues. I have seen patients of this character in the most imminent dan-

* Philadelphia Journal of the Medical and Physical Sciences, Vol. XIV. p. 371. American Journal of the Medical Sciences, Vol. I. p. 424.

ger of suffocation, in a few hours from the commencement of the attack. The effusion sometimes distends the mucous tissue at the root of the epiglottis, forming a small floating pouch. With each inspiratory effort it is drawn into the glottis, occasioning great difficulty in inspiration, though not in expiration. If not speedily relieved, the danger of suffocation is imminent, and the patient may be suddenly destroyed from the pouch becoming firmly engaged in the rima. These two forms of angina have been mistaken for spasmodic croup, the œdematous state of the mucous membrane having been overlooked.

In children, whose blood is rich in fibrin, when the mucous tissue of the larynx and trachea is affected with inflammation, a fibrinous exudation is thrown out, forming an adventitious membrane, which, in most instances, entails a fatal result, though occasionally a recovery takes place, from the detachment and expulsion of the membrane. The formation of this membrane is the peculiar and distinguishing character of croup.

The mucous membrane lining the glottis, when irritated, is often rendered very turgid, from the congestion of blood induced in it. The narrowing of the rima produces in respiration and coughing, a sound very analogous to that occurring in croup. This affection is in consequence frequently mistaken for that disease. It may be distinguished from croup by the suddenness of the attack, and the absence of febrile symptoms. It is easily remedied by an emetic, local or general depletion, warm bath, or other means creating a revulsion of the circulating fluid.

A very nervous temperament will sometimes dispose the muscles of the glottis to be affected with spasms, from irritation of its mucous tissue. It is most common with delicate females. I do not know of its occurrence in children, with whom this temperament is seldom developed. This affection embarrasses respiration, and causes symptoms creating alarm, but is seldom dangerous.

§ 2. *Pathological States of Respiration depending on Nervous Organs and Muscular System of Respiration.*

The disorders of the respiratory function depending on this category are obscure and but little understood. Respiration, it has been shown, is accomplished by certain muscles; but muscular

contraction implies the intervention of nervous organs; and those appropriated to the respiratory movements have been very clearly demonstrated by Mr. Charles Bell. Now, any undue, irregular and pathological actions of those organs must disturb the muscular movements performing respiration, depending on those organs, and that function be proportionally deranged.

The moral affections modify the movements of respiration, through its nervous organs, and hence they are expressive of the moral emotions which influence the function of respiration. Of this nature are the movements of crying, laughing, sighing, sobbing, and in part gaping. These appear occasionally in disease, as a part of the morbid phenomena, and furnish indications of utility. Sneezing is a convulsion of the respiratory muscles, proceeding from irritating impressions on the nasal mucous membrane, but transmitted to the muscles through the respiratory nervous system. It enters also into the pathological state, interfering not only with the comfort, but even threatening the existence of the patient.

Pertussis or hooping cough is a bronchial affection, accompanied with convulsive coughing, which is its distinguishing peculiarity. The last feature is derived from an affection of the nervous respiratory organs. This sometimes continues long after the bronchial disease has disappeared; and on the contrary, the bronchial affection sometimes continues after the nervous affection has ceased.

Singultus or hiccough is a convulsive contraction of the diaphragm, and must undoubtedly proceed from the origin of the phrenic nerve. The exciting irritation of hiccough, is often certainly in the gastric mucous surface, as it is a common consequence of an overloaded stomach; but, its immediate cause is to be looked for in the nervous centres connected with the diaphragm. The influence of sudden moral impressions in suspending it, when slight, is an evidence of the correctness of this opinion. In fevers, attended with signs of meningeal inflammation at the base of the brain, medulla oblongata, and spine, hiccough is a very frequent attendant, is exceedingly uncontrollable, and generally a fatal symptom.

In tetanus and hydrophobia, the fatal termination proceeds immediately, in many instances, it is supposed, from the violence of

the spasms affecting the muscles of respiration, preventing the performance of that function. The patient expires from suffocation.

Dyspnœa or difficult breathing, is a symptom occasionally induced by affections of the respiratory nervous organs. I have seen it having this origin in some cases of fever, with adynamic and ataxic characters, in which the cerebral meninges were highly irritated, and serous effusions existed at the base of the brain. In a young woman in the Alms-house Infirmary, this symptom was strongly marked. In the course of the disease the head had severely suffered from intense pain; the lower half of the conjunctiva was deeply injected, and the lower segment of the cornea became opaque; the eyeball had a constant tendency to roll upwards under the lids. Towards the close of the second week, paroxysms of dyspnœa would suddenly seize her, continuing from three to five minutes, in recovering from which she would mention she had thought she was going off in that spell. The paroxysms increased in frequency and violence, and in the third day from their appearance, she expired in one of unusual severity. No affection of the lungs or heart existed to explain the dyspnœa, but the meninges were highly inflamed with copious effusions. The state of the eyeball connected with this symptom, are corroborative of the views of Charles Bell.

This symptom, in other cases of a similar nature, I have successfully treated by reiterated leeching and cupping on the sides of the neck and behind the ears.

Some obscure cases, attended with pulmonary symptoms, that have occurred in my practice, I am disposed to regard as affections of the respiratory nervous organs. The following is an abstract of one of those cases. A lady who had suffered considerable anxiety of mind, and was accustomed to drink very strong coffee to excess, after exposure in a cold room recently painted, experienced a sensation of oppression and weight at the chest, with difficulty of breathing, which symptoms continued. She had no cough, her voice was faint, and the effort to converse occasioned extreme fatigue. She was often afflicted with severe pain in the head, especially at the back, the extremities were constantly cold, and any mental uneasiness aggravated the symptoms. When the chest was percussed, every region yielded a natural sound; and explored

with the stethoscope, the respiratory murmur was heard distinct and natural in every part of the lungs. After several months duration, the symptoms gradually declined, and health was entirely restored.

§ 3. *Disorders in the Circulation, from Disease of its Central Organ, the Heart.*

The lungs and the function of respiration are subjected to two forces, the heart propelling the blood into the pulmonary viscera; and the muscles of respiration and the atmosphere enlarging the thorax and distending the lungs. A relationship must exist in the actions of these forces, to preserve the integrity of the function: when this is lost, the function is disturbed. A very close harmony is to be observed existing between these different organs, regulating their actions. When the heart is excited, and blood is rapidly driven into the lungs, the muscles of respiration increase their action, to correspond with the more rapid transmission of blood into the lungs, and respiration is quickened. When the heart pulsates with feebleness and slowness, the respiration becomes feeble and slow. A correspondence in this wise, constantly prevails between the quantity of blood sent into the lungs by the heart, and the quantity of air inhaled by the action of the respiratory muscles.

The heart, however, like every other organ, is subject to disease and to various modifications of its structure and function, which destroy the harmony between its actions and those of respiration. When this state is established, the relation between the projectile force of the heart, and transmitting power of the lungs is lost, and the pulmonary circulation is necessarily disordered, inducing disturbance in the respiratory function.

Simple irritation of the heart, seldom is a cause of embarrassment to the respiratory function. It is, however, as I have repeatedly witnessed, productive of hæmoptysis, from the facility with which it becomes strongly excited by moral emotions, stimulating diet, or active exercises. Hæmoptysis, in these instances, proceeds from the too active contractions of the heart, throwing the blood so rapidly into the lungs, as not to correspond with their transmitting power, congestion of the mucous

bronchial tissue ensues, which is relieved by the hæmorrhage. This species of hæmoptysis is entirely distinct, and should be distinguished from that caused by inflammatory irritation seated in the lungs, inviting into them an afflux of blood. The first differs from this last in the absence of cough, except at the time of the hæmorrhage; the patient is often troubled with palpitations of the heart, induced by slight causes; the chest is resonant when examined by percussion, the respiration is natural when explored by the stethoscope, and the lungs are capable of being fully expanded.

The state of the heart the most embarrassing to the respiratory function, is the dilatation of the right auricle and ventricle, and the contraction of the left auriculo-ventricular orifices. The respiration is then short, hurried, impeded; a sense of suffocation prevails; cough is troublesome; hæmoptysis is frequent. The symptoms are aggravated by exercise, by full and stimulating regimen.

Hypertrophy of the heart, unless it has attained a very great development, and is accompanied with dilatation, seldom disturbs the function of the lungs.

§ 4. *Pathological States of the Bronchial Mucous Membrane.*

The importance of this membrane in the pulmonary apparatus, and the intimate association of its functions with that of respiration, places its pathological conditions, amongst the most frequent and most momentous of the causes interrupting the natural exercise of the respiratory office.

Its most frequent morbid state is its irritation. But the effects of this irritation are not uniform; it gives origin to very different conditions of the bronchial mucous tissue, attended with dissimilar symptoms, and interfering with respiration in various modes.

The mucous membranes bear an analogy with the erectile tissues: that is, from their extreme vascularity, they become turgid, and thickened, from the augmented afflux of blood, induced by irritation. Forming, however, secreting and exhalent surfaces, this condition is subdued by the increase of these processes diminishing the sanguine congestion. But when irritation developed in mucous tissues does not excite their secretory and exhalent functions, they acquire a very considerable turgescence.

This state frequently occurs in the bronchial mucous membrane. The caliber of the smaller bronchial tubes is, then, exceedingly diminished, or it may be even obliterated, so as to prevent the air from finding access to the pulmonary vesicles. Respiration must necessarily be nearly suspended; suffocation is threatened; the most violent efforts are made by the respiratory muscles to enlarge the chest and inhale air into the lungs. This condition constitutes one of the forms of asthma.

Irritation of the bronchial mucous tissue, excites in the muscular fibres of the bronchi, spasmodic contractions, in the manner irritations of the intestinal mucous tissue occasion spasms of the intestinal muscular fibres, and by the contraction of the bronchial tubes, asthmatic paroxysms, or suffocative respiration, are induced.

The *exhalent* and *secretory* functions of the bronchial mucous membrane, always experience modifications by its irritations. They are increased in quantity, and suffer various changes in their character. When the *exhalent* action is increased in the large bronchi, a copious expectoration of a clear sero-mucous fluid takes place; it is but slightly viscous, and after standing a short period, acquires a fluidity approaching to that of pure water. When it is seated in the pulmonary vesicles, œdema of the lungs ensues, which, when excessive, terminates in fatal asphyxia.

The *mucous secretion* of the bronchial membrane suffers various modifications from its irritation. It may generally be known by not adhering to the vessel containing it.

When seated in the bronchial tubes, constituting bronchitis, the secretion is often exceedingly profuse; to such an extent, in some instances, as to prove rapidly fatal, by the interruption of the respiratory process. This circumstance especially occurs in the bronchitis of old people, children, and the intemperate. In its character the secretion varies from a sero-mucous to a muco-puruloid fluid, and even to pure pus, though unattended with an ulcerated surface.

The mucus secreted in bronchitis, especially when it has assumed the chronic state, often contains a large portion of fibrin. It is then exceedingly tenacious, often elastic, and I have seen it so firm as not to be divided by the teeth. This kind of secretion

adheres to the mucous surface of the bronchi with great tenacity, and is brought up with exceeding difficulty, and exciting severe and distressing cough. From masses of it nearly closing the large bronchi, suffocation appears at times impendent.

This same membrane, under the action of irritation, becomes often covered with a membranous exudation, the same as that which is thrown out by the laryngeal mucous tissue, in croup. The two are frequently simultaneous, and few cases of croup occur, in which the membraniform concretion does not exist in the larynx and bronchi at the same time. In many instances, this concretion commences in the bronchial mucous membrane, and ascends into the trachea and larynx; in others, it first shows itself in the fauces and on the tonsils, and descends into the larynx and bronchi. This exudation rarely occurs in adults; it is a very common appurtenance of irritation in infants, and is to be apprehended in all the catarrhal and bronchial affections of children. It is by no means improbable, this peculiarity is attached to their fluids, from possessing a larger portion of fibrin.

Irritation of the bronchial mucous tissue disposes, in many cases, to the effusion of blood, which is one of the forms of hæmoptysis. The inhalation of the vapours of the mineral acids, or other irritating vapours, by their direct impression on the bronchial mucous tissue, have often been productive of pulmonary hæmorrhagy. It proceeds also from all the causes indirectly developing irritation on the bronchial mucous tissue. This is the most common form of hæmoptysis, and is that which usually accompanies pulmonary consumption. The chronic inflammation of the parenchymatous structure is extended into the bronchial mucous tissue, and a sanguine exudation results from the congestive afflux induced into it.

In aggravated cases of the acute exanthemata, as small-pox, measles, and malignant scarlet fever, the tracheal and bronchial mucous membrane is affected with intense erythemoid inflammation. Its office in the respiratory actions is invaded, the function of respiration is impaired, and the blood does not experience those changes essential to maintain the organic or secretory and nutritive actions of the economy. To this circumstance may we fairly attribute the tendency to decomposition or putrescency, and

malignancy observable in those cases. May not also the malignant symptoms of fevers of adynamic and ataxic characters, originate from this cause?

The bronchial tubes are frequently dilated beyond their normal size, and give rise to pathological signs. This dilatation extends throughout the whole of a ramification, or it may be limited to a part only, forming an apparent cavity excavated in the structure of the lungs. Sometimes a number of these dilatations succeed to each other with slight intervals, and being filled with mucosities, may be mistaken for tubercular excavations. This aberration is generally produced by violent and continued efforts, as by severe protracted coughs, attended with difficult expectoration, or when none exists.

§ 5. *Pathological States of the Parenchymatous Structure.*

The parenchyma of the lungs is composed of the finer bronchial ramifications, pulmonary vesicles, cellular membrane, and capillary vessels. Irritation of the mucous tissue of the last bronchial tubes and the pulmonary vesicles, attracting into them an afflux of sanguine humour, produces a congestion, opposing in the portion where it exists, the exercise of respiration. Where this condition prevails to a considerable extent, that function suffers to a degree jeoparding a fatal result. This is the pathological state constituting pneumonia. It differs from bronchitis merely in the portion of the mucous tissue affected, which, in pneumonia, is the mucous membrane of the last ramifications of the bronchial tubes and the pulmonary vesicles, necessarily accompanied with extreme congestion; and in bronchitis is the mucous tissue of the larger divisions, the congestion of which is limited. From this close approximation of the two affections, they are often simultaneous in occurrence. They pass into each other without difficulty, and the one is seldom met without some degree of the other.

Pneumonia, in its first degree, is attended with augmented secretion of the mucous membrane. It differs from that formed in bronchitis, in being more viscid and tenacious, adhering strongly to the vessel in which it may be received. In the second and third degree, it loses its mucous character, assumes various aspects, is more or less puruloid, bloody, and putrid.

The parenchyma of the lung, when pneumonia passes into its second stage, becomes solid from the persistance of the congestion, and, probably, a partial organization of the blood: this state is that designated hepatization of the lungs. From this condition, the lung passes to a state of softening, or diffused suppuration, the last degree of pneumonia, when the hepatized portion is infiltrated with a species of sanious pus. This condition of the lung is frequently mistaken for its gangrene.

The inflammation of the parenchymatous structure not unfrequently terminates in gangrene. In the large majority of these cases the gangrene is circumscribed, being limited to a single lobule of the lung; and in all the instances, I have met, of this state, it occurred in the lower lobes. The gangrenous portion sometimes softens down into a putrid sanies, and is discharged through the bronchi by coughing, when a recovery is effected. I have witnessed this circumstance in two cases. General gangrene of the lung is very rare; a single example only has fallen under my notice.

Sanguine effusion takes place occasionally into the cellular tissue connecting the pulmonary vesicles, compressing them in a manner to obliterate their cavities, and destroy their capacity for the respiratory acts. This is the condition of the structure of the lungs in pulmonary apoplexy. It is attended at the time of its occurrence with hæmorrhage, from the rupture of the air-cells and escape of a portion of the effused blood. The blood contained in the cellular tissue coagulates, forming a solid dense mass, bearing a resemblance to a piece of liver. This accident is confined to a single lobule, or several lobules at the same time, but is never diffused throughout a lung, or even a lobe. The lobes adjoining the apoplexed lobules, present the parenchyma in a perfectly healthy condition, the two being separated by an abrupt dividing line.

The cellular tissue entering into the composition of the parenchyma, is intimately connected with the circulation of the lymphatic fluids. Chronic pneumonia, or sub-acute pneumonia, especially in those of the lymphatic temperament, is extended into the cellular tissue, affects the lymphatic capillaries and circulation, causing the secretion of tuberculous matter, a product of lymphatic irritation, and a modification of albumen. In their first

stage they are disseminated through the parenchyma, where they occur in small particles, and do not occasion much embarrassment to respiration. But continuing to increase by the persistence of the irritation inducing new secretion, they compress the air vesicles, and render the lungs solid. Finally softening down, the tuberculous matter is expectorated, leaving cavities of various size in the lungs. The superior lobes are the portion in which tubercles with almost uniform constancy first appear. To this species of structural degeneration, the term phthisis pulmonalis is now restricted. As far as my observations in private, and public practice in the Alms-house infirmary, where annually a large number of patients perish with this disease, have enabled me to form an opinion, phthisis is always preceded either with bronchial or pneumonic inflammation of acute or chronic character.

The pulmonary parenchyma under chronic inflammation, is frequently converted into a dense substance of a homogeneous structure, nearly as firm as cartilage, and of a grayish colour. Laennec regards it as of the same formation as tubercles, and names it *tuberculous infiltration.* Like tubercles it is connected with the cellular tissue and the lymphatic humours, and is a product of irritation or perverted nutrition. It is more properly *gray induration* of the parenchymatous structure.

The cellular tissue of the lungs is sometimes infiltrated with air, causing emphysema of the lungs. It may exist to such an extent as to impede respiration, by compression of the air cells. Violent efforts to cough, as in pertussis, and difficult expiration, when the larynx is obstructed, as in croup, I have known to produce this condition.

§ 6. *Pathological State of the Pleuræ.*

Inflammation of the pleura changes the character of its surface, and modifies that of the fluid serosity lubrifying it. This departure from its natural state, divests the pleura of its proper office, intended to admit of the easy movement of the lungs in their expansion and recession in the act of respiration. This function is consequently embarrassed, and when both pleuræ are thus affected, the patient is placed in imminent danger, more especially when the portion lining the diaphragm is involved.

Irritation of the pleura is always productive of serous or lymphatic effusion of various extent, and compressing to a greater or less degree the lungs, opposing their expansion, and preventing the access of the atmosphere. When this condition prevails in both pleural sacs, suffocation is speedily induced.

§ 7. *Properties of the Air, the Medium of Respiration.*

If the function of respiration suffers derangement from the imperfections to which its apparatus is exposed, it is subject on the other hand, to be disordered by the alterations and vicissitudes, incident to the atmospheric air.

The function of respiration is exposed to disturbances of various kinds from atmospheric influence, by the following causes: *a.* Its physical properties; *b.* Its composition; *c.* Its vitiation by foreign matters: and through this function they exert a potent action over the entire organism.

a. The physical properties of the air, its density or rarity, its dryness or moisture, and its temperature, are powerfully influential over the respiratory function and the state of the economy. In health this agency is experienced in a sensible manner by every one, but in a pathological condition, its power is most obviously manifest.

A dense is more favourable to respiration than a rare medium; the functions and force are more active and vigorous in the one, than in the other; and patients whose lungs have been diminished in capacity by disease, suffer an aggravation of distress in a rarefied air, while they breath with quietness when the atmosphere is dense.

An air unusually dry, creates a sense of stricture and oppression of the chest, and is productive of head-ache. It is exceedingly unfavourable to those labouring under chronic pneumonitis, either before or subsequent to tubercular development. It often induces paroxysms of asthma, and is hurtful to the plethoric, and those of sanguine and nervous temperaments.

A very moist atmosphere does not comport with a perfect performance of respiration, though it is less oppressive than its opposite state. It disagrees with those of the lymphatic temperament, which is developed by a residence in humid climates; and

it exposes to the diseases attached to that temperament. Scrofulous patients, and those threatened with that disease, should be transferred from a moist climate, to regions where the atmosphere is dry and warm. This atmosphere is adapted to all the pulmonary affections, attended with chronic inflammation of the pulmonary structure. It is this circumstance that has rendered the marshy pine woods of Jersey celebrated for their beneficial effects in consumption and diseases of the chest. I have found advantage in diseases of the lungs, by keeping the patient constantly in an atmosphere loaded with moisture from the evaporation of water.

A humid and very warm atmosphere produces considerable embarrassment to respiration, and occasions general lassitude.

The most pleasant and salubrious air, in which the respiratory organs exercise their functions with the greatest ease, and the economy experiences the most healthful feelings, is an atmosphere moderately warm, and saturated with moisture to the extent of its solvent powers; the humidity being then combined with the air, is not sensible.

The temperature of the atmosphere, is a powerful modifier of the respiratory function. A low temperature condenses the air, and the effects of a dense medium are produced. But extreme cold, as when the thermometer falls below zero, gives painful sensations in the lungs, and often awakens acute inflammations of those organs. Persons who have irritable lungs, or are predisposed to pulmonary disease, should be careful, when they expose themselves to a cold air, to cover the mouth and nostrils, to avoid its sudden inhalation.

An elevated temperature is highly perturbating to respiration. This fact has already been alluded to, and an explanation hazarded as to its operation, (see p. 419.) The breathing is quickened, hurried, and short, especially when exercise is attempted, and a real asphyxia is often induced. Consumptive patients, whose lungs have suffered very considerably, and those who have to contend with chronic pneumonia of advanced stage, are severely annoyed by an elevated temperature. The heats of summer witness annually the fatal termination of a large number of the cases of that character. For such patients, a climate of moderate heat, and secure from rapid vicissitudes, is that adapted to a prolongation of life, and sometimes facilitates a recovery.

b. In the composition of the atmosphere, the proportion of oxygen is exactly adapted to the wants of the economy; to its agency in the maintenance of the organic actions, and the healthful constitution of the organs and functions. Any deviation from this proportion is attended with more or less of degeneracy in the condition of the organism, from the vitiation induced in its actions. Its augmentation never occurs, and the only aberration of which it is susceptible, is its diminution below the normal standard. It is this circumstance that renders the habitation of confined, ill-ventilated apartments unwholesome, and when they are over-crowded, causes the production of fatal disorders. Hospital, jail, and typhoid fevers, hospital gangrene, and other diseases of putrescent character, are to be attributed to this cause. It is a well-established fact, that for the regular and healthy exercise of the functions and natural condition of the animal structure, an average of forty cubic feet of atmospheric air, constantly renewed, must be enjoyed by each individual. Precisely as he is deprived of this quantity of air, and compelled to live in a space with a less portion, or its renovation is prevented, his functions are impaired, and his organism deteriorates. When the quantum of air is reduced considerably below this standard, and at the same time is confined, death very speedily ensues. The most noted instance is the terrible catastrophe of the black hole at Calcutta, in 1745. The garrison of the English fort at Calcutta to the number of one hundred and forty-six men, who had surrendered themselves prisoners, were shut up at eight o'clock in the evening, in a room only eighteen feet square, and having but two small grated windows. They soon experienced great thirst and difficulty of breathing, and sweated profusely. Their sufferings rapidly augmented; they were driven to despair and rage, and a violent contest ensued for the possession of the windows, the strongest trampling the feebler beneath them. Four hours subsequently to their occlusion, those who had not been able to approach the windows were in a state of asphyxia or heavy lethargy. When the prison was opened the next morning, twenty-three only were taken out alive; and most of these were attacked with a *malignant fever*, that proved fatal to the larger portion.

The same cause occasions the head-aches, vertigoes, palpita-

tions, fainting, and other disorders affecting feeble individuals, whenever they frequent crowded assemblies. Feeble persons, and those whose health is impaired, especially those suffering under pulmonary and cardiac diseases, should cautiously avoid numerous collections of people, the habitation of confined rooms, and especially sleeping in warm and close apartments with other people. I have had two cases of cardiac disease induced by this last cause, though for a single night, in travelling, and which required a treatment of twelve months to remove.

c. The air may be vitiated or altered in a great variety of manners. The most common are the decomposition of animal and vegetable matters, the vapours of bodies in combustion, and the emanations from the bodies of individuals, and from living vegetables.

Animal and vegetable substances, in a state of putrefactive decomposition, disengage various elementary principles forming gaseous compounds of different kinds, contaminating the air with noxious and morbific qualities. The principal of these are sulphuretted, carburetted, and phosphuretted hydrogen, carbonic acid, ammonia, &c. The first of these gases is exceedingly deleterious. In the experiments of Thenard and Dupuytren, an atmospere containing one part of this gas in a hundred, was fatal to the most vigorous dogs; and most commonly one part in three hundred, caused asphyxia in a few seconds. It is exceedingly probable that other principles are formed, but which have escaped detection in the limited and imperfect researches instituted on this subject, and which may be productive of some of the injurious consequences proceeding from bodies in putrefaction.

When the putrid miasms are concentrated, they occasion often a prompt asphyxia, and in a more diluted state, they are, notwithstanding, scarcely less dangerous, though less rapid in their effects. Many epidemics have been attributed, by medical observers, to animal and vegetable matters in decomposition, and that fevers and visceral inflammations are generated in this manner, is a fact too well substantiated to be questioned.

The atmospheric air is vitiated by the vapours generated in combustion, and when the air is not freely renewed, asphyxia is a certain consequence to those exposed to their influence. These vapours are carburetted hydrogen, and gaseous oxide of carbon,

and carbonic acid. In coal mines the air is depraved by an admixture with nearly the same gases and hydrogen, in a degree to disqualify it frequently for the purposes of respiration.

Some metals, when exposed to heat, contaminate the air by their emanations, and through the lungs affect the economy with serious disorders; such are mercury, lead, arsenic, and antimony. The diseases produced are violent pains in the articulations, cerebral and nervous disorders, paralysis, apoplexy, violent colics, consumption, &c.

The green parts of living vegetables in the shade, disengage carbonic acid, and vitiate the atmosphere in close rooms: when the sun shines on them, the reverse action occurs; oxygen is discharged and carbonic acid is absorbed and decomposed. The petals and stamens of flowers impregnate the air with their odorous emanations, and often seriously affect the function of respiration and the nervous system, causing syncope, head-ache, convulsions, difficult breathing, with sense of stricture in the chest, and retardation of the action of the heart. The odour of ipecacuanha produces dyspnœa with many individuals.

The air is often vitiated by emanations impossible to be recognised by any known means of examination, yet capable of profoundly affecting the human organism. Such are the emanations proceeding from the bodies of individuals labouring under certain diseases, as the exanthemata, the inhalation of which communicates a similar disease. The mere assemblage of a number of sick in confined rooms, vitiates the air to such a degree, as to render the breathing of it extremely dangerous, exciting various disorders, but not necessarily of the same character as those producing the emanations. These emanations have received the appellation of *miasms.*

The air is modified by insensible qualities it is impossible to detect, but which exercise a profound influence over the organs of the economy. The term atmospheric constitution, was first employed by Sydenham, to express this unrevealed governing power of the air. The qualities of the air are manifested often in extensive epidemics, as the influenza, which has been known, not only to spread over whole continents, but even to make the circuit of the globe. The characters and production of diseases are strongly controlled by them. In certain series of successive

years, without any appreciable difference in the known properties of the air, particular diseases prevail epidemically, as certain fevers, dysentery, &c. To these succeed other series of years, apparently the same, but in which diseases totally different prevail, the former have entirely disappeared, and a new character is acquired. Some individuals, I have known, who experience an attack of asthma the moment they leave this city. There are several gentlemen of my acquaintance, who have for many years been attacked with a violent catarrh and defluxion from the head in the midst of summer, occurring with great regularity on a fixed day. What these qualities are, it is not in our power to determine or to conjecture, but the effects are too obvious not to recognise their existence.

CHAPTER IV.

On the Function of the Circulation, or the Distribution and Movements of the Blood or Sanguine Nutritive Humour.

The preparation of the blood or sanguine nutritive humour, constituted of the nutritive elements furnished by the aliment, and the humours of venous and lymphatic absorption, is completed in the lungs by the function of respiration. This fluid, thus prepared, is adapted for the maintenance of vital phenomena, the nutrition of the organs, and the secretions. But it requires to be distributed, for these purposes, to the various organs composing the animal organism, which is accomplished by the function of the circulation, through the medium of the vascular system.

The circulation differs exceedingly in the various kinds of animal organization. In the simplest form, (infusaria, polypes,) no circulation properly exists. It is not necessary. The structure is homogeneous—consists of similar elements and atoms. Nutrition and respiration are an imbibition from an external or internal surface, and each constituent atom has but a single relation to the other constituent atoms, and to exterior agents. The movements

of the fluids is the effect of a kind of electric attraction and repulsion. In the simplest of the vegetable forms, no vessels are existent, and no movements of fluids occur; or where vessels are found, there is merely an oscillatory movement of the nutritive fluid.

In a higher species of animal organization, different elements concur in the formation of the animal structure, and various organs execute different functions. Each structure requires a different element, and has its separate relations to exterior agents; and each organ possesses a demand for a special supply of fluids adapted to its function. An apparatus, then, became requisite to furnish each tissue with its supply of nutritive elements, and to place at the disposal of each organ, the materials necessary for its particular office. This apparatus is the vascular system. With the lower animals, (vermes,) the vascular apparatus consists of simple vessels distributing the sanguine fluid. Others more complicated, (crustacea, molusca, pisces,) have a single heart or propulsive organ added to the vessels, whose mechanical action forces the blood through the vascular system; and with the more perfect animals, (mammalia,) the vascular system rises in complexity with the rest of the organism; it is arranged into a double circulation, respiratory and nutritive, each one distinct; and is provided with a double heart, one appropriate to each circulation.

The vascular system and circulation, follow the development of the respiratory organs and function, with which they are closely associated. When respiration in the animal organism becomes concentrated on a surface, vessels for the first time appear, conducting to it the nutritive fluid, and when a complex apparatus is appropriated for the respiratory function, a complete vascular system with a heart or propelling organ, is consigned for the special purpose of conveying all the fluids and moveable disengaged molecules into that apparatus, to be submitted to the exercise of its function.

The vascular system thus forms two principal divisions; the one intended for the organic actions or nutritive functions, and on which depend immediately all vital phenomena, commences by the radicles of the pulmonary veins, and terminates in the innumerable ramifications and radicles of the aorta, in the intimate structure of the various tissues and organs of the eco-

nomy. At the junction of the pulmonary and aortic portions of this division, is seated the systemic or aortic heart, giving impulse to the movement of the blood in its course from the respiratory to the organic or nutritive capillaries. The other division, intended for the reparation of the nutritive sanguine humour, arises by venous and lymphatic radicles in the intimate structure, and terminates in the ramifications and minute branches of the pulmonary artery in the lungs. Where the systemic and pulmonary portions of this division meet, the pulmonary heart is situated, joined to, without communicating with the aortic heart, and impelling the venous blood in its course from the organic or nutritive capillaries of the various tissues and organs into the pulmonary capillaries, for its reconstitution into arterial blood. The first division contains arterial or red blood, whose movement is eccentric; the second contains venous or black blood, whose movement is concentric.

In this manner of viewing the vascular system, the heart, in the circulation, acts as a physical apparatus placed in its circuit, imparting force by its mere mechanical powers to the movements of the blood in mass, but exercising no influence over its direction. It is essential, in the animals of more complicated organization, to their existence, because, without its energy, the transmission of the blood in columns through large vessels, from the nutritive capillaries to the pulmonic or respiratory capillaries, and its return back again, could not be executed with the rapidity necessary to maintain the organs in their activity. But the importance of the heart in the circulation, is derived, entirely, from its mechanical office in maintaining the supply of arterial or oxygenated blood in the capillaries of the organism.

The circulation, or rather distributive movements of the blood, is connected immediately with every vital phenomenon. The reciprocal action between the solids and sanguine humour, is the essential motion in which life consists, and, consequently terminates whenever the supply of this humour ceases. Every deviation of this humour from its natural state, or the proportion of its supply in any organ, impresses a modification on the actions of the organs and the phenomena they manifest, and while the natural proportion between the solids and fluids of an organ continues to exist, a pathological condition cannot prevail. A pathological state of an

organ, is, then, always an evidence of an irregularity, of a departure from the normal order of its circulation, or the movements of the organs and supply of its sanguine fluid; and this irregular or anormal state or distribution of the sanguine fluid, is one of the primary and most important links of the pathological condition.

A correct knowledge of this function in all its details, becomes then, indispensable to the appreciation of morbid phenomena; and unless the character of the circulation is thoroughly comprehended, it is impossible to acquire just and positive ideas of the diseases of the organs, or be led to the adoption of sound principles in pathology. The mode of viewing the circulation, has always been the governing principle of medical systems; whence originated the principles of their pathology, and by which was regulated the methods of their treatment: it has formed the nucleus of their growth. The recognised errors of most systems of medicine, have sprung from the incorrect and vicious opinions entertained in respect to the circulation, based on a partial knowledge, a superficial and too limited view of this most important and widely-diffused function. It is, therefore, of the first consequence in the attempt to determine the truth as to the physiological and pathological states of the organs of our economy, to study with close and observing attention the phenomena of the circulation.

To this investigation we now proceed, and shall continue the system previously pursued, by instituting an analysis of the various constituent departments or divisions that concur in the composition of this complex function. These will form the following subjects: 1st, the arterial blood, or sanguine nutritive humour; 2d, the apparatus or organ of the circulation; 3d, the mechanism of the circulation, or mode in which it is executed; 4th, the moving forces of the circulation; and 5th, its pathological conditions or anormal state.

SECT. I. *Of the Arterial Blood, or Sanguine Nutritive Humour.*

The blood, the product of hæmatosis, is apparently a homogeneous fluid, in animals with red blood, of a bright vermilion colour. When seen by the microscope while circulating in the minute vessels, in diaphanous tissues, it appears to consist almost exclusively of minute globules, but which from their exceeding

mobility evidently float in and are borne along by a very tenuous fluid. The translucency of this last prevents it from being discerned; and the globules alone are to be distinguished. Consequently, where these do not penetrate, it is not possible to discover with the microscope any appearance of moving or circulating fluids, though the tissues may be permeated by them.

The sanguine fluid, when first drawn from a vessel, exhibits a uniform appearance and character. But it is nevertheless composed of two parts: the one nearly or perfectly colourless, and having great tenuity; the other possessing more density, and consisting of globules, with which is combined the colouring matter.

A short time after the blood is abstracted from the vessels, these two parts separate, forming the serum or liquid portion, and the crassamentum or clot, having a certain solidity and spongy texture. In the act of coagulation, it is generally asserted that caloric is disengaged, though Dr. J. Davy declares he could not detect it.

The crassamentum consists of the colouring matter of the blood and of fibrin, by the concrescence of the particles of which coagulation is accomplished. This process is prevented by a variety of circumstances, as too elevated or too low a temperature, agitation, and the admixture of certain neutral salts. The cause producing the concretion of the fibrinous particles is not known, but it displays its force at times in the living subject, and coagula are formed in the vessels. It bears most probably a part also in the process of nutrition. By simply washing the crassamentum with water, the colouring matter is removed, leaving the fibrin in its natural state, and showing the two are not chemically combined, but merely held in admixture.

The globules of the blood have been variously described by different writers. This was to be expected in the early period of microscopical observations, when perfect accuracy in the use of so delicate an instrument was scarcely to be looked for, or an entire exemption from mistakes could be possible. I am strongly disposed to believe that Hewson mistook minute air bubbles for globules of the blood, as his description of these last corresponds exactly with the appearance always presented by air bubbles. In the commencement of my own observations, I fell into this error, and had drawings made delineating the blood globules, corresponding exactly with Hew-

son's description, but subsequently I discovered the deception. The accounts of nearly all the other observers, agree very closely, and are conformable to what I have seen. They are represented as flattened spheres, with a depression in the centre, and consisting of a nucleus or central globule, surrounded by a coloured envelope. The exterior envelope is detached with great facility from the nucleus, and the colouring matter dissolves readily in water; hence the perfect globules are to be seen only in blood recently taken from the vessels. According to Mr. Bauer, whose observations receive support from those of Messrs. Edwards and Dumas, the central globules or nuclei freed from their coloured envelope and united together, constitute the fibrin of the blood.

The size of the blood globules has been variously estimated, and no certain standard can be relied on: what, however, appears very certain is, that it differs considerably in different animals, and has no relation to the bulk of the animal: for the blood globule of the frog is larger than that of man.

The essential elements of the blood consist of serum, of fibrin, and of hematosine, or the colouring matter. The proportions of these cannot be established with positiveness, as they vary from numerous circumstances.

Serum is composed chiefly of water, holding albumen in solution, with various saline principles, and coagulates by heat and the influence of galvanism. When coagulated, a portion retains the fluid state, which is termed serosity. Numerous, regular, and rounded corpuscules or globules, are observed in the serum when examined with the microscope, resembling the blood globules deprived of their coloured envelope. According to Mr. Bauer, they do not appear in the serum until after it has been removed from the vessels some days; but this is most probably owing to the mere condensation of the fluid by evaporation, rendering them more apparent.

The fibrin is identical with the muscular fibre, whence it has received its appellation; it is also named coagulable lymph. It is obtained artificially by washing the crassamentum; it is of a grayish or yellowish-white colour, possesses a remarkable tenacity, and considerable elasticity. According to most micrographers, it is composed of globules, analogous to those of the blood deprived of their colouring matter.

The colouring matter or hematosine is a peculiar animal principle. It abounds in the crassamentum, from which it does not separate spontaneously, and can be procured only by chemical processes. It is of semi-liquid consistency, and deep red, or when dry, nearly jet colour. Seen with the microscope, it presents the appearance of numerous small bodies floating in a liquid, which are conjectured to be the fragments of the decomposed globules.

While the preceding are regarded as the essential and characteristic elements of the blood, other principles are detected in it, and enter into its composition: such are albumine, held in solution in the water of the serum, cerebrine or the fat matter of the brain, urea, sulphur, peroxide of iron, lactate of soda, soda, chlorides of sodium and potassium, sulphate of potassa, and phosphate of lime and magnesia.

The sanguine fluid thus contains the immediate or remote elements of the animal tissues and secretions, which are separated from it by the processes of secretion and nutrition in the different organs. At the same time it is the sustainer of the organic actions or vital phenomena.

The quantity of the nutritive humour has been variously estimated; but, it is evident, it cannot observe a constant proportion, and must vary with different individuals, and in the same individual at different epochs.

It is not equally distributed to every organ; each one having a certain sum, or proportion, appertaining to it. The most elevated in the scale of vitality, are those most richly furnished with blood. The natural proportion is always destroyed in disease, and this constitutes the most important and striking feature of the pathological state.

All the elements of the blood do not equally circulate in, or penetrate into all the tissues. The red or coloured globules have no natural relation to, and are not found in the cellular, serous, fibrous, and cartilaginous tissues, and the medullary portion of nervous tissue: they do not enter into the circulation of these tissues in a natural state. The complex tissues nourished and penetrated by red blood, containing as components a portion of the white tissues have also in them a separate circulation of colourless blood. This circumstance is of deep importance, and ought to be kept in

view in the study of the pathological state, and the just appreciation of its phenomena and characters. For the process called irritation will be attended with different phenomena, and will generate entirely different products in the white tissues nourished with albuminous or colourless blood, and in the red tissues, nourished with coloured blood, abounding in fibrin.

Sect. II. *Apparatus or Organs of the Circulation.*

The apparatus of the circulation has a physical construction, adapted to convey or conduct fluids, and impress on them motion. It is composed of vessels, *(arteries* and *veins,)* and a heart or hearts. In some of the lower animals, *(vermes,)* the circulation is executed by vessels alone, having, however, on the main trunk the addition of a muscle, giving impetus to the movement of the blood, analogous to, or being the first rudiment of a heart. In animals of more complex structure, a heart is added. At first it is single, having but one auricle and one ventricle, and propels the arterial blood, or is aortic, as in the crustacea and most mollusca; or it moves the venous blood, or is pulmonary, as in fishes.

Animals of the higher orders have a double heart, or more properly speaking, two distinct hearts, though adherent to each other, one appropriated to each circulation. The respiratory or pulmonary heart propels venous blood into the pulmonary apparatus, to be revivified by the process of respiration; the nutritive or aortic heart receiving the blood from the lungs, transmits it into the tissues and organs of the economy for the objects of nutrition, and the excitement of vital phenomena.

A small fraction only of the whole mass of sanguine fluid is positively contained in the vessels at the same moment, and can be said to be actually circulating. The larger portion exists in the capillary vessels and areolar texture of the organs, in which its movement is not progressive in mass or column, but is oscillatory, vortical, and molecular. This part is renewed gradually and in successive portions, by the receipt of new molecules from the vessels of supply, (the arteries,) and is consumed in the processes of nutrition and secretion.

These several parts of the apparatus of the circulation, require a summary notice.

§ 1. *Vessels or Arteries and Veins.*

The *arteries* are elastic tubes with solid parietes, conveying the blood driven by the impulse of the heart, into the capillaries and areolar structure of the organs. Their anatomical structure has been described in Part I. They are implanted in the ventricles of the heart, into which they open. The one conducting the blood into the body generally, from the left ventricle, is the aorta; that transmitting the blood from the right ventricle into the lungs, is the pulmonary artery. The two have exactly the same structure. The arteries are constituted to resist the impetus of the heart communicated to the blood; and this is the sole cause of their difference from the veins. The arteries are nearly passive in the circulation: they have no active participation in that process. By their elasticity they yield to the distending force imparted by the contraction of the ventricles, but immediately react with slight increase of force as that ceases. In this manner the impulse derived from the heart is continued on the blood, and its progressive movement is maintained during the relaxation or diastole of the heart. The elasticity of the arteries has the same operation, though more perfectly, with the air-vessel in hydraulic engines, contrived for the purpose of maintaining a constant current of water through tubes, by continuing the pressure on it, during the retraction of the piston.

The function of the arteries in the circulation is entirely mechanical, depending solely on their physical form and properties: it possesses nothing of a vital character. Many physiologists still hold the belief, that arteries are furnished with a muscular coat, and have, consequently, an active participation in the circulation by a contractile power. This opinion was first adopted before the existence of general anatomy had carried the lights derived from an analysis of the structure, into the study of the tissues and their properties. It was a bare hypothesis, and once formed and embraced, attempts were made to sustain it by some crude and inconclusive experiments. Not only do we know, from anatomical analysis, muscular fibre to be absent from the structure of arteries, but chemical analysis establishes the same fact, by proving it does not contain fibrin. The arteries devoid of muscular fibres, endowed with no other contractile force than that of mere elasticity, can exercise no active and controlling influence on the cir-

culation; and all doctrines assuming their contractility as a principle or fact for their basis, have not a foundation in nature, and are necessarily defective and erroneous.

All those explanations of the formation of congestions, undue excitement, and accumulation of sanguine fluid, in the organs, derived from a supposed active determination of the blood into them, by a direct action of the heart and vessels, are entirely hypothetical. No power of the kind is possessed by them. The blood may move quicker or slower, according to the frequency and force of the contractions of the heart, but the quantity sent into the organs will always hold the same relative proportion.

The *veins*, in structure, are less solid, resisting, and elastic, than the arteries; they are more yielding and distensible. Experiencing none of the impetus of the heart's contraction, it would have been unnecessary they should have been endowed with the same physical powers of resistance, while from the slower movement of the returning blood, and its liability to temporary retardations from numerous causes, it was proper they should have the power of enlarging under those circumstances, to contain an increased quantum of that fluid.

The differences in the structure of the arteries and veins proceed from their middle or proper coats. In the veins, this is either peculiar to them, being sui generis, or is a modification of the yellow elastic fibrous tissue, forming the middle coat of the arteries. The internal or lining membrane is the same in both, though in the veins it is disposed at intervals in folds, forming valves, which aid, on mechanical principles, the feebler circulation in these vessels. Neither set of vessels are furnished with a structure susceptible of active contractions.

The veins execute a function analogous to that of the arteries. Both passively admit, by their physical conformation, the passage of fluids through them, which are propelled by forces foreign to the vessels themselves. They are mere conductors of the sanguine fluid, but in opposite directions. The arteries being afferent, and the movement of the fluid centrifugal; the veins being efferent, and the course of the blood in them centripetal.

The veins commence in the manner the arteries terminate; that is, in exceedingly minute and almost imperceptible ramifications and divisions. In the arteries these form series decreas-

ing in caliber, and increasing in number; in the veins the order is reversed, decreasing in number, and increasing in capacity. The veins are infinitely more numerous than the arteries in the general system, though the fact is doubtful as to the pulmonary organs; and they are estimated to contain at least three-fifths of the *actual circulating* fluids.

It was long a favourite notion, and is not yet entirely abandoned, that the arteries and veins were directly continuous, the one commencing from the termination of the other. The movement of the blood, as regarded in this manner, was considered a complete circulation in the strictest sense, passing through the arteries, and immediately returning from them back again through the veins. The impossibility of explaining the physiological phenomena of nutrition, secretion, calorification, and of the pathological phenomena of congestion, inflammation, and anormal productions, by this hypothesis, was not perceived, and in truth, were scarcely inquired into by physiologists and pathologists, who were generally content with seeing, without attempting to understand them.

That a direct communication exists between some arterial and venous ramifications, and that an immediate transmission of the blood from the one to the other really occurs, I do not doubt. It is said to be demonstrated by anatomists, who occasionally succeed in making the matter of injections pass from an artery into the veins; and in examining the circulation with a microscope, it is common to observe in the field of vision, one or two of the currents of blood globules suddenly change their course, making a circuit, and from being centrifugal, to become centripetal. In the salamander, and other animals of lower order, the direct communication of many vessels is very obvious. It is not, however, true of all the veins; and the larger portion of them arise by imperceptible radicles in the intimate and areolar structure of the tissues and minute capillaries. When we shall treat, in a succeeding section, of the mechanism of the circulation, the object answered by a partial direct communication of the arteries and veins, and the necessity of such a provision will be indicated.

§ 2. *Of the Capillary System.*

It is only since the epoch of the appearance of the General Anatomy of Bichat, that the capillary system has been regarded generally as distinct from the arteries and veins, and its highly important functions in the production of vital phenomena been duly estimated. It must be acknowledged, however, that of this structure, our information is exceedingly defective, and the existence of these minute vessels is rather inferred than demonstrated. In tracing most carefully the course of an artery towards its termination, it is seen to diminish until it vanishes from the sight; it is equally impossible to seize on the first origin of a vein. The examination of delicate and transparent tissues by the microscope, exhibits numerous currents of globules. Some of these, as we have already remarked, in making a circuit, assume a retrograde course; others proceed in a regular route, though dividing infinitely, but return into afferent vessels, while other globules move in various directions with fluctuating course, often are arrested, and become fixed in the tissue, while the same, or different molecules again separate, form new currents, and re-enter the circulation.

Examined in its natural state, the tissue presents amidst the currents of moving globules, many spaces of apparently solid substance, resembling small islets, surrounded by an agitated fluid. But if it be slightly irritated, as by thrusting in it a fine needle, immediately the motion of the globules is more rapid, new currents start into existence, where none were before perceptible, and the whole becomes a mass of moving molecules, the general direction of which tends towards the point of irritation.

The last circulation would, from these observations, appear to be of three different kinds; one direct between the arteries and veins; a second through capillaries intermediate to the arteries and veins; and a third in the areolar or interstitial structure of the organs. The two last are generally embraced as one, constituting the *capillary system.*

The capillaries enter so intimately into the composition of the minute structure of the organs, it is no more possible to describe them, than it is to give a description of the intimate texture itself. All we do know is, that while arteries and veins are of

an appreciable size, and their circulation is under the influence of the heart, they cannot be said to constitute a portion of the tissues of the organs; they are distinct from them, and the interior parenchymatous circulation of the organs, for the purposes of nutrition, secretion, and the other phenomena of life, is not performed by them, but by the capillaries.

The capillaries thus constitute an immense system, every where continuous from the continuity of the external and internal surfaces, embracing all the organs, from the largest to the most minute, executing the organic or vital actions, and susceptible of being influenced throughout its whole extent by impressions on any one portion.

The capillaries must possess some differences in the different tissues, and even in those entering into the composition of the same organs. For, in some organs, as the spleen and mucous membrane, the circulating or nutritive humour, is almost exclusively red or coloured blood; while in cartilage, fibrous membrane, serous membrane, it is, in a natural state, solely colourless blood that circulates in or permeates them. Their capillaries cannot therefore be precisely similar.

In the structure of the same organ are found dissimilar tissues, as in the lungs, liver, stomach, &c. nourished by different elements of the blood, and admitting in healthy action, the one red blood, and the other only colourless fluid. Corresponding with this difference in the capillaries, the blood we have just seen, consists of different portions, coloured, or red globules, and a colourless fluid with globules of the same character.

The capillaries present also two great divisions, in which very opposite actions take place. The one is the capillaries of the organic structure, engaged in nutrition and secretion, and in which the blood loses its capacity for maintaining the vital phenomena, or is changed from arterial into venous blood; the other is the capillaries of the lungs, in which the reverse action occurs; the blood acquiring the capacity of exciting and supporting vital actions, and is changed from venous into arterial blood.

§ 3. *Of the Heart.*

The heart is a muscular organ, whose contractions give impulse to the motion of the blood, accelerating its course from the one set of capillaries to the other. It is not absolutely necessary to a circulation, or distribution of nutritive fluid in organized beings. The animals of simple structure are devoid of it; and the circulation of vegetable beings, often very active and energetic, is entirely carried on without its assistance.

The heart is not constructed on the same model in all animals. In one class, *(vermes,)* it is a mere muscular coat added to a portion of the large arterial trunk: in another, (the *mollusca,)* it is an enlargement of the vessel with the addition of muscular layers: in others, *(reptilia* and *pisces,)* it is single, and is pulmonary, or propels venous or black blood into the lungs, or is aortic or systemic, driving arterial or oxygenated blood into the general system. In the mammalia, the heart is double, or, more properly speaking, is two hearts conjoined together, but having no immediate or direct communication with each other after birth—the one being pulmonary, or transmitting venous blood; the other systemic, and impelling red or arterial blood.

The heart in man, regarded as a single organ, presents four cavities; two auricles, and two ventricles. The left, or rather posterior auricle and ventricle, communicate with each other, and form the left, aortic or systemic cavities; the right auricle and ventricle, opening into each other, are the right, or pulmonary cavities.

The ventricles compose the body of the heart, and are formed of firm muscular walls. The muscular fibres of the ventricles are not continued to the auricles. The auriculo-ventricular orifices are furnished with valves, admitting the influx of the blood from the auricles into the ventricles, but preventing its reflux; while the openings of the pulmonary artery and aorta are also provided with valves arranged to admit the passage of the blood from the ventricles into the vessels, but equally preventing its return. The ventricles act on a large mass of blood, and impel it through an extended space. Their muscular structure possesses a proportionate development; and the left, as requiring the most force, has the thickest parietes.

The auricles are considerably thinner than the ventricles, having much fewer muscular fibres, which, in fact, are not necessary, as they merely force the blood into the ventricles during their relaxation. The auricles communicate with veins; the right being connected with the cava ascendens and cava descendens returning the blood from the inferior and superior portions of the body; and the left with the pulmonary veins, bringing the blood from the lungs. No valves are placed at the openings of the veins into the auricles, so that the column of blood is continuous from the interior of the auricles to the venous radicles. The auricles may, with propriety, be looked on as venous enlargements, forming reservoirs for the supply of the ventricles, reinforced by some muscular fibres to drive the blood forward into the ventricles. In this view, the ventricles alone are to be considered as properly the heart: it is they that impress the impelling force on the column of blood in both the circulations, pulmonary and systemic.

The interior cavities of the heart are lined by the same delicate membrane, forming the inner coat of the blood-vessels, with which it is continuous: of the same tissue also are constructed the valves situated at the auriculo-ventricular openings, and the orifices of the large arteries. No differences can be perceived in the structure of this tissue in the venous or arterial vessels, and the two hearts; yet the venous membrane, and that of the right or pulmonary heart, is more distensible than the other, and is seldom found ossified which is a common occurrence in this membrane in the arteries and aortic heart. This membrane is very irritable, and susceptible of inflammation.

The heart on the exterior is invested by a serous membrane, which is reflected from it at the origin of the vessels, forming a kind of sac enclosing the heart. On the exterior of this is applied a layer of fibrous tissue, connected with a similar tissue in the diaphragm, and is continued on the large vessels coming to, or arising from the heart. The serous covering is provided, as in other organs where it exists, to admit of easy and unresisting movements in the heart, and for this purpose it is lubricated by a serosity exhaled on its surface.

The nerves of the heart are remarkably small. They follow the distribution of the cardiac arteries. It was, for a considerable

period, denied that the heart received any nerves, and the source whence they are derived is not yet absolutely determined. The most probable opinion is, that they receive some filaments from the eighth pair, and others from a plexus of the trisplanchnic.

The structure of the heart is calculated entirely on physical principles, and intended for the development of a mechanical action on the blood. Its influence in the circulation is solely that of a physical apparatus, similar to a forcing pump in an hydraulic engine. It can have no controlling power over the course or direction of the circulation, which is influenced by it in no other manner than by the force and frequency of its contractions. In the irregular distribution of the circulating, or nutritive humour, so important a feature of the pathological state, it does not possess the slightest agency.

Sect. III.—*Mechanism of the Circulation.*

The apparatus described in the preceding section, has for its office or function the performance of the circulation, or movement and distribution of the nutritive humour. The manner in which this is effected, and the forces accomplishing it, are an interesting subject of inquiry; one that is deeply involved in pathological discussions, and the determination of therapeutical principles.

The blood, or circulating liquid, may be regarded as distributed into three portions, according to the part of the vascular system containing it. The first is the portion included in the arteries moving from the heart towards the capillaries. It is the least in quantity. The second is that contained in the veins returning the blood from the capillaries: its quantity exceeds considerably the first. The last is the portion existing in the minute capillaries and interstitial, or areolar texture of the organs, and is immediately engaged in the production of vital phenomena, nutrition and secretion. It is by far the most considerable portion of the sanguine mass; its movement is not progressive, but fluctuating, and it is gradually renewed. The two first portions can alone be considered as actually circulating in a constant current; the last is detained in the organs, and its movements are directed by the organs themselves.

The circulating blood, or that contained in the vessels, pre-

sents every where a collection of continuous and moveable columns, having the two hearts or ventricles for common bases. It is confined in the vascular system, 1st, by the parietes of the vessels, which, by their physical properties, react on it; and 2d, by the capillaries and areolar texture of the organs, replete with their portion of the sanguine nutritive humour, which admit only the quantity required for their immediate actions, and to replace what they transmit to the circulation. From the direct communication between the arteries and veins, a true circulation is performed, the blood passing immediately from the one set of vessels into the other. By this mechanism an impulsion communicated to the base of the circulating columns is experienced, at the same moment, throughout the whole mass, and the movement of the circulation is not, consequently, as is generally represented, in successive waves, but is consentaneous in every portion. The proper vascular system or circulating apparatus, has no immediate agency in the organic actions; it is merely intended as a system of supply, conveying to the capillaries and areolar texture, the fluids appropriate to their especial functions.

The blood contained in the capillaries and areolar texture of the organs, does not enter into the circle of the circulation: properly speaking, it does not circulate. Its movements are not always progressive, but are molecular, fluctuating, and oscillatory. A certain quantity of sanguine fluid is essential to every organ, is one of its elements, and can in no manner be abstracted from it. This portion is really an organic fluid. The general quantity of the blood in the capillaries and areolar texture varies according to its greater or less abundance in the economy, and the actions of the organs attracting into them additional supplies, forming local congestions, and disturbing the balance of its distribution.

The capillary system and areolar texture of each organ, derive their sanguine or nutritive humour from the vascular system and general circulation, by an independent force. They admit or attract it from, retain or return it into the vascular system and general circulation, according to their mode of excitation, which always governs their demand, or the necessity of a supply. Each organ is, consequently, the regulator of its own circulation, and determines the quantity of sanguine humour it contains. This

quantity is specific in each organ, depending on its organic and functional actions, but admits a certain fluctuation resulting from the states of activity or repose of the organs.

The erectile tissues offer a type, on a magnified scale, of the capillary system and areolar texture, and of the phenomena composing the circulatory movements of which they are the seat. The erectile tissue in the penis, clitoris, nymphæ, nipple, &c. consists of innumerable capillaries anastomosing together, and a cellular or areolar structure, with which the capillaries freely communicate. The large vessels convey to this tissue at all times, the same quantity of blood, placing this fluid within its reach and at its disposal. But, unless it be in a state of excitement, no more blood enters it than is required for its nutritive acts. As soon, however, as it experiences an excitement, either moral, from sensual ideas, or physical, from lascivious touchings, it attracts immediately a large quantity of sanguine fluid, becomes turgid, and in a state of erection, and retains the blood within it as long as the excitation is continued. When this ceases, the attractive power of the tissue terminates, the blood passes into the venous vessels, and a state of flaccidity and relaxation ensues.

When a general plethora prevails, the vascular and capillary systems are turgid with blood, and the organs possess their greatest development, fullness, and activity. In the deficiency of this fluid the circulating portion is maintained at the expense of the capillaries and areolar texture, which are deprived of a portion of their sanguine fluid; the organs contract to their smallest dimensions, and the energy of their organic actions declines. In sudden excessive losses of the fluids, emaciation is rapidly induced from this cause, the features shrink, and the size of the limbs diminishes. The formation of congestions in the internal highly sanguine organs, is attended with similar results, as the excess of fluids accumulated and locked up in those organs, occurs at the expense of the rest of the economy, which is called on also to furnish a sufficiency of blood to maintain the circulation in the vessels.

The sanguine fluid of the capillaries and areolar texture, the organic fluid, experiences incessant mutations. It is the subject of the molecular actions, consisting of nutrition and secretion, and the production of vital phenomena, in which it suffers a complete

metamorphosis. It loses part of its elements, and a portion of its molecules become fixed in the formation of the solids and the secretions; it acquires other elements and molecules from the decomposition of the animal structure, and its arterial or oxygenized state is exchanged for the venous or carbonized character.

The capillary and areolar circulation are the most important to be studied in their peculiar features, as being the seat of all the movements in which the vital phenomena are generated. They are the essential agent in nearly all the pathological and therapeutic modifications impressed on the organs and economy.

The preceding exposition I take to be the correct view of the mechanism of the circulation. It is founded on an investigation of facts furnished by anatomical researches, *(injections, &c.)* by a careful study of the circulation in living animals with the microscope, and by the phenomena manifested in the pathological state, and in therapeutic operations. The views taken by writers of the circulation, are, in general, too exclusive. Some, with Harvey, continue to regard it as performed exclusively in the vessels, by an uninterrupted connexion of the arteries and veins: others, with Bichat, consider the capillary system as entirely intermediate to the arteries and veins, preventing the direct transmission of the blood from the one to the other set of vessels. Neither of these doctrines alone can explain some of the most important facts connected with the circulation, nor is either separately consonant with some of its most absolute phenomena. Both, with the limitations given to them, are true. A capillary circulation, as described by Bichat, unquestionably exists; and in addition, a parenchymatous or areolar circulation, in which the nutritive sanguine fluid possesses a molecular movement; in both which the circulation is effected by inherent forces. A direct circulation also exists between the arteries and veins; the arteries forming a curve, and the blood returning immediately back to the heart. This last arrangement is necessary for the safety of the economy in those sudden and extensive congestions, so frequently formed under the influence of vehement irritations developed in highly sanguine organs. In these cases, the blood in the capillaries and areolar tissue, does not return into the vascular system; it assumes a direction towards the point of irritation, where it accumulates, is detained, and more or less stagnates, which condition constitutes

the state known as congestion. This state, when extensive, or seated in the large and sanguine organs, as it respects the vascular circulation, is equivalent often to the abstraction of many pounds of blood, whence proceeds the feebleness of the vascular circulation when this condition prevails. The heart is almost powerless from the diminution of the circulating mass of blood, and the deficiency of supply to its own capillaries; the pulse is miserable, and scarcely to be distinguished, for the artery is not distended, nor its coats put on the stretch, by the volume of fluid traversing it; and the external surface, when the congestion is internal, is pallid and algid, because deserted by its sanguine humour. If a direct circulation had not been provided, every congestion, of even moderate extent, would have been necessarily productive of a fatal syncope. The vascular circulation must have ceased, from the sudden detention of the blood in the capillary system and parenchyma of the organs, under the influence of an active irritation, and the detorsion it impresses on the whole of the capillary circulation. The necessity of a direct circulation is manifested, and in this arrangement is displayed a striking instance of the profound designs and beautiful harmony prevailing in every portion of the organism.

Sect. IV. *Of the Forces accomplishing the Circulation.*

From the anatomical characters of the arteries and veins, as clearly examined in a preceding section, it is very evident they can exercise but a very limited influence in producing the circulation or movement of the blood. Their agency in this respect is restricted entirely to their physical properties, depending on their structure. The arteries, by their elasticity, which they possess in an eminent degree, when the vascular system is well supplied and distended, react on the column of fluid, and assist in maintaining, in the manner previously explained, the progressive motion of the blood. The shock or impulse communicated by the contraction of the ventricles, and the sudden injection of blood into the arteries, is experienced throughout all their ramifications, produces a slight distention, and it is asserted, a feeble lateral motion. This shock or impulse is perceived when an artery is felt, and forms the pulse. The force and firmness of the

pulse always corresponds to the distention of the arteries, and is an evidence that the vascular system possesses its full quantum or an excess of the sanguine fluid. But when the amount of the circulating fluid is diminished, the arteries collapse in proportion to its diminution, their reaction on it is lessened, and the pulse is feeble; and when the abstraction of the blood from the vascular system is so considerable, as no longer to fill the caliber of the arteries, and distend their coats, the pulse disappears, and can no longer be felt, though a stream of blood may still continue to flow through the vessels.

Many writers strenuously contend for an active participation in the circulation on the part of the vessels, and they have endeavoured to prove in them the possession of a contractile power, similar to muscular contraction. Dr. Hastings, of modern authors, is the most conspicuous for his labours to establish this point. His evidences are, however, exceedingly defective, and weigh very lightly in opposition to the conjoined result of anatomical and chemical analysis, disproving absolutely the existence of muscular fibres in the composition of the arteries, sustained, in addition, by the experiments of Bichat, Majendie, and Parry. The principal experiments of Dr. Hastings are obnoxious to very forcible and important objections. The contraction manifested in an artery after it has been laid bare, is one of the strong facts relied on to establish its muscularity. This contraction is not manifested immediately, as all muscular contractions are, when resulting from an irritant, and is a consequence of the evaporation of the watery portion of the serous fluid, constituting so large a portion of all the solids, and which always occurs when a part is denuded. The tunics of the arteries are consequently condensed, and their diameter is diminished.

Sulphuric acid applied to an artery also produces a diminution in its diameter, and this is also assumed as an evidence of muscular contraction. But concentrated sulphuric acid attacks every part of the animal structure to which it is applied as a chemical agent, changing its character and properties, and the contraction of an artery from this cause can never be admitted as a test of its muscular structure. Besides, sulphuric acid, from its strong affinity for water, attracts that fluid from all bodies with which it is placed in contact, and this cause alone, by producing condensa-

tion in the coats of the arteries, will occasion diminution of their caliber. It would be remote from the elementary design of this work, to enter into a critical analysis of the other experiments of Dr. Hastings, but they can be shown to be equally inconclusive with those already noticed.

The vessels exerting no other agency in the circulation than that derived from their physical structure and properties, we have to look to the heart and the capillaries, and areolar texture for the active powers producing the circulatory and distributive movements of the sanguine fluid.

The *heart*, by its structure and contractile power, is unquestionably a very efficient agent in the circulation of the blood. By many writers it is considered as the sole cause of the circulation. The ventricles contracting from an inherent vital force on the blood they contain, which is continuous with that in the arteries, act on it with a physical impulse. The blood being mobile and unresisted in the direction of the arteries, moves along them, from the impulsion given by the ventricles. The action of the heart in the circulation is thus seen to be entirely mechanical, and it can impress no other modification on it, than what may arise from the greater frequency or slowness, force or feebleness of the ventricular contractions. It cannot alter in any respect the distribution of the circulating fluid; it cannot direct, at the same time, a larger quantity into one organ, and a smaller into another, the caliber of the arteries being nearly unchangeable, and the relative proportion sent to each organ must, consequently, be always the same. The phenomena of disease constantly manifests, however, an unequal, irregular distribution of the sanguine humour amongst the organs, some having an excess, and others a deficiency of it. The distribution of the blood to the organs cannot therefore be accomplished by the heart alone.

By the mechanical impulse of the heart, the blood is propelled through the arteries to the organs, where a large portion of it is taken up by the capillary and areolar system, as it may be required, for the uses of the organs; the remainder is propelled into the veins through the direct anastomosing branches, connecting the two series of vessels. The heart is consequently the moving force of the *vascular system*, and maintains the circulation of the blood. The vascular system supplying the capillaries and areolar

texture of the organs with the sanguine humour requisite for their circulation and actions, the last is held in an immediate and absolute dependance on the first, and the cessation of the action of the heart necessarily entails the failure of the capillary and areolar circulation, and termination of the organic actions and vital phenomena. The heart is consequently a vital organ, on whose integrity the whole organism is held dependent. We are here presented with another example of the mutual dependency of the organs and functions on each other, especially those of the same category and apparatus, which has been previously instanced; for, already the influence of the capillary on the vascular circulation has been shown, and we now perceive the reverse influence of the vascular over the capillary circulation. In man, and the higher animals, whose organic actions necessitate an incessant supply of arterial or oxygenated blood, the capillary and areolar circulation terminates nearly simultaneously with the cessation of the vascular. But in the inferior and cold-blooded animals, which do not require the same continuous afflux of arterial blood for the maintenance of their organic actions, the capillary circulation does not cease entirely with the extinction of the vascular circulation; it has been known to persist for some time even after the excision of the heart.

Many calculations have been made to estimate the force of the heart's contractions. Some of them have been very extravagant. It is not easy, from the imperfect character of the data, to arrive at positive conclusions. Besides, the contractions of the heart are continually varying, from the operation of numerous causes. A very high degree of power is not required for the functions deputed to the heart, and it is not probable that it possesses more than is called for by its office.

The successive motion of the blood in the arteries, proceeding from the ventricular contractions, gradually declines with the diminution of the diameter of the vessels in their increasing ramifications, until, in the fine capillaries, it disappears entirely, the blood escaping from them when divided, in continuous streams. The influence of the heart is experienced, partially, in the venous circulation, through the direct anastomosing communications, and a slight throbbing movement is to be observed at times in the stream of blood flowing from a vein.

Though the influence of the ventricular contractions is experienced in the venous circulation, it is not the sole agent accomplishing the movement of the blood in these vessels. Other causes contribute to the same purpose. When treating of respiration, the assistance furnished to the venous circulation, by the expansion of the thorax and lungs, was pointed out. The dilatation of the heart has also an operative agency in effecting the venous circulation. The blood is pressed forward in the veins by a vis à tergo, formed of the conjoint action of the ventricles in the manner described, of the capillary radicles of the veins, and, to a slight extent, of the atmospheric pressure, to which Dr. Barry assigns too much importance. The heart being the terminating point of the veins, when its cavities dilate, and a tendency to a vacuum is formed, the resistance to the motion of the blood being removed, it rushes forward with an increased velocity; and, thus, the dilatation of the heart is an accessary to the venous circulation, or the return of the blood from the periphery towards the centre. The agency of this last means in producing the venous circulation, though it has attracted some attention in late works, is the least important of those signalized as concurring in that design.

The heart, when the organs and functions are in a natural condition, contracts, in adult age, from sixty-five to seventy-five times in a minute, and isochronal pulsations are experienced throughout the whole of the arteries. The pulse is, consequently, an index to the actions of the heart, and the condition of the vascular circulation. In proportion to the earlier age of the individual the contractions are said to be more frequent.

The cause whence proceeds the contractions of the heart, has long engaged the attention, and foiled the speculations of physiologists in their endeavour to explain it. Haller, and his disciples, assigned it to an inherent irritability of the fibres of the heart, stimulated by the presence of the blood. This hypothesis is the most rational and probable, though it certainly is not without its difficulties. Le Gallois, and most of the French physiologists who have adopted his views, regard it as depending on a nervous principle derived from the spinal marrow. This opinion emanates from the general doctrine that inculcates irritability to be a property attached to the nervous system, and imparted by it to the organs. The fallacy of this doctrine was exhibited when treating

on that subject, (Part I. Chap. III.) The experiments of Le Gallois are entirely inconclusive; for the results on which he depended, it has been satisfactorily shown, were due to the manner of their performance, and not to the experiments themselves. When the brain and spinal marrow are destroyed in a gradual manner, the contractions of the heart will continue, if artificial respiration be maintained, and hæmorrhagy be prevented. Besides, monsters have existed with a heart and circulation destitute of brain and spinal marrow.

The nerves which the heart receives are not for the purpose of communicating to it a principle or capacity of action, but are intended to connect it with the organs of the economy. The heart is one of the centres of life, and regulators of the vital phenomena. As such it must be placed in the most intimate relation with the other centres of vitality, and respond to all of the principal organs. By the ganglionic nerves it is associated with all the viscera of organic life, and especially with the stomach and small intestines; and is directly allied with the brain by the cardiac branches of the par vagum, and, indirectly, through the cardiac plexus, whence it experiences the influence of the passions and emotions. Associated in this manner, indirectly, or by sympathy, with the digestive apparatus, and with the brain, and immediately connected, as has been demonstrated with the respiratory apparatus, and the capillary system, the heart partakes in nearly all the morbid irritations, and pathological deviations of the organism, and the pulse as an index of the heart, becomes the index to nearly every morbid or pathological state.

It is not, then, without foundation, that physicians have, in all periods, paid the highest regard to the pulse, as the most certain guide in determining the general state of the economy, and the condition of the organs. For the heart, by its connexion with the different organs through the ganglionic system of nerves, experiences a modification in its mode of being and actions, from the diseases of each, and thus presents, as it were, the reflexion of their various pathological states. Deficient, however, in a correct knowledge of the sympathies, and unacquainted with a rational theory of the pulse, and its various states, writers have refined to such an extent the differences of the pulses, have established so many artificial divisions, and rendered them significant of so

many various shades, and forms of disease, as to have obscured, rather than enlightened this medium of diagnostics and prognostics. The exceeding minuteness of their indications, casts a doubt on the accuracy of their observations, and leads to a just suspicion that the sphygmic art has partaken too often of imaginative speculations, rather than of a study and a due appreciation of the real phenomena. At the close of this section will be presented a theory or doctrine of the pulses, and their most important modifications, exhibiting their production, and the value of the signs they impart.

It has already been shown, that, in the lower animals, and in vegetables, a molecular and capillary circulation of very considerable force and activity prevails, independent of a central moving organ, or heart. It must, consequently, be accomplished by a force innate to the capillary structure, and the organs of those beings. The law of analogy, observed throughout organized beings, is sufficient to establish, that, in the higher animals, the molecular and capillary circulation proved to exist in them, is governed by a similar independent force. The heart and vascular system is appended in them to the capillary system, in consequence of their more complicated structure; and, more especially, of the greater number, and augmented activity of their vital phenomena. That principle, or quality of the sanguine nutritive humour, directing and sustaining the vital movements and phenomena of the organs, being more speedily exhausted, a more rapid supply became requisite. The heart, as has been demonstrated, is not, then, intended for the accomplishment of the whole circulation, but merely to accelerate the alternate transmission of the blood from and to the two divisions of the capillary system, nutritive and secretory, and respiratory.

This view of the independence of the capillary circulation on the impulsion of the heart is not a novelty. It was fully appreciated by Stahl and Van Helmont, and sustained by Bordeu. Darwin, in the Zoonomia, attempts to establish its truth. But the most complete illustration of this great principle, the master-key to the study of physiological, pathological, and therapeutic phenomena, is the admirable chapter on the capillaries in the General Anatomy of Bichat.

Having acquired the demonstration of the existence of an in-

dependent force directing the capillary circulation, or movement of the blood, the nature of this force now presents itself as the subject of inquiry. But, on this point, it is not possible to arrive at any satisfactory conclusions. It is too closely associated with the primary cause of vital phenomena, and occurs too profoundly in the intimate structure of the organism, to be detected in the present state of our knowledge, and by our actual means of research Our acquaintance with physiological dynamics is, as yet, exceedingly superficial; and a very considerable period, most probably, will elapse before physiologists can pretend to designate with certainty the immediate agents of the greater portion of the phenomena manifested in organized beings. In science, and especially in the physiological sciences, we must frequently be content to reduce our pretensions to the observance of phenomena as they exist, with their mutual dependancy and order of occurrence. We may often determine positively a fact, and settle its relations, without being able to penetrate its cause; and this is the full extent to which, for the present, we are permitted to carry our knowledge of the active force of the capillary and areolar circulation.

An hypothesis respectable from the advocation accorded to it, explanatory of the capillary circulation, merits to be noticed. It is assumed, that the capillaries are endowed with an expansive and contractile power, somewhat analogous to the heart; and consequently, that their action consists of an alternate imbibition and expulsion of the sanguine fluid. M. Broussais, who formerly espoused this doctrine, but which, it is believed, he has since renounced, pushed it to the extent of asserting the capillaries to be the heart of the veins.

Most writers regard the capillaries as furnished with muscular fibres, and as conducting their circulation by muscular contraction. This is the prevalent doctrine of the English and of many French physiologists, even of those who deny muscularity and irritability to the large arteries. No substantive proof has, however, been adduced to establish the fact; and when the capillary circulation is examined by the microscope, with which it can be seen most distinctly, it is utterly impossible to observe the slightest appearance of active contractions and dilatations, or any movement of the globules of the blood indicating the existence of simi-

lar actions. It is in vain to assert that the movements of the vessels are so delicate as to escape detection. The globules of the blood, more minute than the vessels themselves, are distinguished in the clearest manner, and their motions are discerned without difficulty. It is not possible to inspect their movements, it is my impression, and believe they proceed from any action of the vessels.

M. Pruss, to explain the species of erection manifested by the capillaries, from the accession of fluids they experience under the influence of irritation, has conjectured them to possess expansibility, as an innate vital property. This hypothesis would not deserve a notice, had it not received countenance from the respectable authority of Dr. Hodge, of this city,* who has adopted a similar view. This mode of solving a difficulty is cutting the knot, and offers no explanation of the phenomenon. A resort to an ultimate occult cause should be adopted with great reserve in science. It is justifiable only when every explanation by other means is absolutely impossible, and an action of any known cause is not applicable to the phenomena. Such, however, is not the fact, with respect to the distention of the capillaries under excitement. In the erectile tissues, where the order of the phenomena can be closely observed, the erection they manifest, it is very evident, is a consequence of the afflux of the fluids into the tissue; and the afflux of the fluids is not a consequence of the expansion of the tissue. The same circumstances, it is presumable, prevail in the capillary actions, and the erection or injection of capillary vessels, is due to the same or an analogous cause, producing the erection of the erectile tissues.

Many of the most distinguished German physiologists, who have closely investigated the phenomena exhibited by the capillary circulation, have been led, from observing the independent motions of the sanguine globules in the capillaries and parenchymatous structure of the organs, to attribute their movements to an innate property, a species of vitality, similar to that of the infusoria, and to be the result of spontaneity.

This doctrine is sustained by Carus, Treviranus, Dollinger, and Kaltenbrunner. All of them concur, with Haller, Spallanzani, and

* North American Medical and Surgical Journal, Vol. VI. No. 11.

nearly the whole of the modern micrographers, who have made the capillary circulation the subject of observation, in denying active or positive contractions in capillary vessels, as a cause of the movements of the blood in them. The distinguished names enlisted in the support of this doctrine, entitle it to be received with attention; and the facts cited to illustrate it, are certainly not destitute of speciousness. Still it is an approach to the doctrine of ultimate occult causes, and a multiplication of first causes, which should be the last resort of philosophy.

More probable than any of the preceding hypotheses, is the suggestion, that electro-galvanic power generated in the nervous system, and through it acting on the blood globules in the capillary system and parenchymatous or areolar structure, is the immediate agent directing the movements or circulation of the blood in the capillaries and parenchyma of the organs. The following circumstances may be adduced as corroborative of this position.

1st. The organic actions, vital or organic chemistry, and the capillary or parenchymatous circulation, as exhibited in Part I. Chapter III. are so intimately associated as to constitute a circle of actions of the same order, and depending on the same cause. This cause, reasons were adduced to show, might possibly be electro-galvanism.

2d. The nervous system exercises a decided influence over the capillary circulation. This is evidenced by the phenomenon of blushing, from mental impressions and sentiments; by the disorder of the secretory actions arising from strong moral emotions; and by the sympathetic transmission of irritations from one organ to another.

3d. Treviranus has shown, that when the spinal marrow is destroyed, the capillary circulation ceases, although the action of the heart and general circulation may be continued.

4th. It is now an established fact, that electric currents impart magnetic properties to needles and iron bars through which they may be directed.

5th. The experiments of Dr. Beraudi demonstrate, that needles placed in nervous cords, become magnetic, the force of which corresponds to the quantity of oxygen consumed in respiration. When the animals are made to breathe hydrogen or azote, the magnetic force is not produced.

6th. It is established by electro-dynamic experiments, that two electric currents passing in *opposite* directions impart a repulsive, and in the *same* direction bestow an attractive power. Now, the globules of blood, in the circulation, exhibit a species of polarity. They repel each other, or attract each other under particular circumstances that cannot as yet be defined.

7th. The experiments of Dutrochet and Wedemeyer clearly prove electric currents to be capable of producing with fluids the phenomena of a capillary and parenchymatous circulation.

The preceding investigation of the apparatus and the function of the circulation, presents as a result; 1st, a vascular or direct circulation performed in vessels, the active or moving power of which is the heart; and 2d, a capillary, areolar, or parenchymatous circulation, having an active, motive force or power, not yet clearly ascertained, but which, it is not improbable, may possibly be electro-galvanic agency acting through the nervous system. The two are mutually dependent, and influence each other, yet the actions or movements of each are governed in a totally different manner, and by entirely distinct principles. The vascular circulation, is the movement of the blood in columns or in mass; the capillary and areolar circulation is a molecular movement. The vascular circulation is effected chiefly by mechanical action; the capillary and areolar circulation, by vital or dynamic forces. The phenomena belonging to the two kinds of circulation, have no analogy, either as connected with physiology, pathology, or therapeutics; they must be studied separately, and the reciprocal influences, and individual peculiarities of each be determined. We shall hereafter have occasion to show, that in pathology and therapeutics, the most vital errors have been committed, and are daily perpetrated from confounding the two, and regarding the circulation as a unity, to which the same general principles are applicable, in settling the diagnosis of a disease, and the operation of curative means.

Sect. V. *Of the Pulse and its Modifications.*

Until the nature and character of the circulation was investigated and established, the pulse and its modifications, with their value as signs, could not be treated on rational principles, or correctly estimated.

Of the vascular circulation, the pulse is an absolute indicator, pointing out its condition in a positive and direct manner. It does not respond as immediately to the various states of the capillary circulation; but, as this last exercises a controlling influence over the vascular circulation, through it, the pulse indirectly exposes the condition of the capillary and areolar circulation.

The pulse, it has previously been shown, is caused by the shock communicated to the whole mass or column of blood contained in elastic vessels, *(the arteries,)* by the contraction of the ventricles. The vessels opening into the ventricles, and the blood being a continuous mass in a natural state, completely occupying the cavities of the heart, vessels, capillaries, and parenchyma or areolar texture of the organs, when the ventricles contract, the blood they contain is forced into the arteries, and the sanguine column included in these vessels, receives a simultaneous impulse in every portion. The pulse is not, consequently, produced, as was long supposed, and is still conjectured to be, by a succession of waves following each other through the vessels. It is every where synchronous, and the diastole of the arteries corresponds with the systole of the heart. Spallanzani, in examining the action of the vessels, expressly remarked, in several of his experiments, that the pulsation in the aorta, the mesenteric artery, and its smallest ramifications, was instantaneous. "The aorta," he observes, "when the heart contracted, swelled up at once from its origin to its termination." And although from his notion of the circulation he supposed "the pulsations must occur in succession," yet he acknowledges as the result of his numerous experiments, "that at the very moment the heart contracts, the aorta and the whole of the arterial system seem to beat at one and the same time."

It has been a subject of dispute whether the arteries experienced a dilatation in consequence of the impulse communicated to the blood by the contraction of the ventricles. A very slight dilatation certainly does occur, though much less than was formerly supposed, or might be believed, from observing superficially the pulse. This point appears to be very accurately settled by the experiments of Spallanzani, Parry, and Poiseuille.

Three circumstances govern the pulse, of which it furnishes the indications: 1st, the frequency or slowness, force and rythm, or order of the ventricular contractions; 2d, the quantum

of blood actually contained in the vessels or proper vascular system, which is governed by the state of the capillary and areolar circulation; and 3d, the state of the arteries.

1st. The pulse depending so much on the action of the heart, partakes of all its aberrations from the natural state, and these deviations are the consequence of idiopathic affections of the heart, or of its sympathetic disorders. The last are the most common, for the diseases of acute, and most of those of chronic irritations, extend their influence to the heart, and involve it in the morbid condition.

The modifications of the pulse arising from the contraction of the heart, are those affecting its frequency, slowness, force, and rythm or mode of pulsation.

Frequency of the pulse is the most constant and certain symptom of an existing irritation in the organs. Whenever the heart experiences irritation, either sympathetically or primitively, its contractions are quickened, and so long as a frequent pulse continues, whatever may be the improvement of other symptoms, we should always suspect a lurking inflammation, and endeavour to exterminate it. The diminution of the frequency of the pulse, in acute diseases, is uniformly a favourable sign, while its persistance is as positive an evidence nearly of the continuance of the disease. In convalescence from gastro-enteritic fevers, after the perfect reinstatement of the alimentary organs in their healthy state, I have frequently found the frequency and irritation of the pulse continue, and every attempt to increase the diet or invigorate the patient by tonics, to be attended with febrile excitement. The irritation of the heart in these cases, at first merely sympathetic, had become established permanently, and did not terminate with the cessation of the primary irritation. It is to be overcome by local depletion from the cardiac region, blisters to the same part, small bleedings, and restricted regimen. If neglected, organic disease of the heart will sometimes succeed, or the patient be cut off by dropsical effusions.

Frequency of the pulse may be combined with its force and fulness, but they do not necessarily accompany each other.

The contractions of the heart, in the majority of persons, average from sixty-five to seventy in the minute; above that number, the pulse is said to be frequent. It often mounts as high

as one hundred, one hundred and twenty, and seldom beyond one hundred and fifty in the minute.

When the contractions of the heart are very feeble, from the emptiness of the vascular system, they increase in frequency, as though the deficiency in the quantity of the blood circulating, was to be compensated by the increased velocity of the circulation. It is scarcely possible to mistake the frequency of the pulse from this cause, for the frequency produced by irritation. It is always attended with extreme weakness of the pulse.

Quickness of pulse differs from frequency; it has reference to the time of each pulsation, and depends on the systole of the heart being performed with a rapid contraction. Most commonly it accompanies frequency of the pulse, and is an evidence of existing irritations. The frequent pulse of exhaustion is generally a quick pulse.

Slowness of pulse is usually employed as opposed to its frequency, and expresses the fewer number of pulsations than is usual in a given time. Rareness or paucity of pulse would be a more correct designation, to distinguish it from slowness, as contrasted with quickness. The diminution in the pulsations of the heart, manifests the absence of irritation in that organ, or its declension, if they had been previously frequent. Rareness or paucity of pulse accompanies at times a full and strong pulse, particularly in the congestions of the cerebral organs, and is also an attendant on a small and feeble pulse, especially in chronic diseases, attended with serous effusions. It is produced by digitalis, which appears to be a specific action of that remedy, diminishing the irritability of the heart, and consequently the number of its contractions.

Slowness of pulse, as opposed to its *quickness*, has relation to each pulsation. It arises from the same causes as rareness of the pulse, a state of ab-irritation or asthenia of the mobile organ of the circulation, and sometimes of the softening of its parietes.

A strong or forcible pulse proceeds from the energy of the ventricular contractions. Most commonly it belongs to a fulness of the vascular system, or plethora, and manifests excitement and vigour in the heart. It attends on hypertrophia of the left ventricle.

A feeble pulse, marks in most instances, a low state of excitement in the heart, and indicates exhaustion of the vascular sys-

tem. It may be accompanied with slowness or frequency. In carditis and pericarditis the pulse is said to be feeble, which then proceeds from the disability of the ventricles to contract, like other muscles, when they or their sheathes are in a state of acute inflammation.

The last modification of the pulse emanating from the heart, relates to its rythm, or mode of action. In this respect, the pulse may be equal or regular, unequal or irregular, and intermittent. In a regular or equal pulse, all the pulsations are similar; a pulse is unequal or irregular, when the pulsations do not correspond to each other in frequency, quickness, and force; a pulse is intermittent, when, after several pulsations, there occurs a momentary repose. These conditions of the pulse proceed from different modes of contraction of the ventricles. The irregular and intermittent pulses belong to organic diseases of the heart, and occur also in acute diseases, from sympathetic disturbances in that organ, which, I am disposed to believe, are only excited by irritations of the digestive organs. At least, I do not recal pulses of that character in the diseases of other organs, except of the heart itself. The irregular is a more unfavourable than the intermittent pulse. I have known instances in which an intermittent pulse was natural to the individual; it continued for years, and during the enjoyment of good health.

2d. The capillary system modifies the pulse, as to fulness or emptiness, by determining the quantity of blood contained in the vascular system, and regulates, in these respects, the state of the direct circulation. This last supplying the capillary system, which attracts from the arterial and withholds from the venous vessels the proportion of blood it requires determined always by the state of its excitation, the vascular or direct circulation is governed, as to its repletion or vacuity, by the state of the capillary circulation in the different organs. Fulness or emptiness of pulse are, then, indications of the condition of the capillary circulation. These states of the pulse are produced, however, under particular circumstances, and in a manner requiring to be noticed.

When a limited extent of the capillary system is engorged with blood, as occurs in inflammation and irritation, and its circulation is sluggish or suspended, the portion thus affected, ceases to ad-

mit further supplies, for the time, from the artery conveying the sanguine humour to it. The amount of blood previously transmitted into the capillaries, is now accumulated in the artery, and passes into the veins exclusively by the direct communication existing between these vessels. They are consequently replete with blood—the artery, completely distended, is full and hard, and it more perceptibly manifests the momentum of the heart's contractions. This I regard as the correct explanation of the full, strong pulse, felt in the arteries supplying an inflamed part of limited extent, as in the radial artery, in very acute inflammation of the hand.

Inflammation of the brain or meninges with light congestion, produces the same effect in the carotid arteries; and to a greater extent, the same circumstance is observed in the extreme congestions of the brain, as in apoplexy. In these cases, the pulse of the whole vascular system, is full, strong, and often slow. The degree and extent of the congestion, which occupies the external as well as internal capillaries, arrests the capillary movements, and of course the demand of these organs, receiving in a natural state, as is estimated, an eighth of the whole circulating fluid, while the general torpor of the capillary system throughout the economy, which attends on this disease, diminishes, in some degree, the call made on the circulating fluid. The vascular system, in consequence, acquires a repletion of blood, the vessels are distended, the pulse is full and strong, and as no irritation exists in the heart, its contractions are slow.

Precisely the reverse is the effect, on the general or vascular circulation and pulse, of irritation in the extensive membranous tissues rich in capillaries, and in capacious organs of highly vascular structure, producing in them profound congestions. The quantity of blood these organs and tissues are capable of containing, and which, under the influence of irritation they abstract and withhold from the vascular system, is so great as to reduce the general circulation to a state of extreme exhaustion. A small, deficient current flows through the arteries and returns immediately by the veins; the heart is in a state of asthenia, contracts with feebleness on its half-distended cavities, and the pulse is scarcely to be perceived, and is sometimes entirely absent, when the volume of blood is not adequate to bring the elasticity of the arterial coats into action.

In the commencement of irritations of the internal viscera, es-

pecially of the digestive or alimentary organs, before reaction, or the irradiation of the irritation into other organs has ensued, the capillary and areolar circulation of the external surfaces is diminished, the capillary circulation concentres towards the seat of irritation, where the blood accumulates and is detained until it is dispersed by the establishment of reaction. This concentration of the circulating or nutritive humour in a portion of the capillary system, forms the cold stage of fevers, and is the essential condition of visceral congestions, which have formed so prominent a feature of late in some systems, though their mode of production was not understood. Its direct effect is to abstract blood from the vascular system, equivalent to a depletion, and the quantity of blood of which the vessels are deprived, is proportioned to the intensity and extent of the concentric movements of the capillary circulation, and degree of congestion induced; it is often equal to the abstraction of many pounds of blood. Hence arises, in this state, the weak, feeble pulse, a sign of debility in the contractions of the heart, and emptiness of the vessels.

The same result, as to the vascular circulation and pulse, is caused by extensive irritations of the cutaneous surface, productive of sanguine congestion of its capillaries. This state exists in the eruptive fevers, or exanthemæ, when of a high grade, and which are, then, attended with a weak, empty pulse. Scarlatina, when of intense character, as in its malignant form, is a remarkable illustration of the fact. The disease, in this state, exhibits the skin from the head to the feet of a deep red, demonstrating the actual presence of red blood in the skin, in a quantity entirely unnatural. The internal mucous tissues, in this malignant form of the disease, is shown by dissection to be in the same condition. Here then is presented the ocular demonstration of the permanent congestion of the cutaneous capillaries, the detention of a large quantity of the circulating fluid in them, and its consequent deprivation from the vascular system. Now, in this form, or stage of scarlatina, the pulse is always deficient in fulness and force, and in the highest grades of the disease, the pulse is reduced to such extreme exility, it is scarcely distinguishable.

This feeble, empty pulse of scarlatina maligna, has been supposed to be the consequence of extreme debility of the vital powers, and to require the sustaining energy of stimulants and

tonics. I have never witnessed from their employment, more, even when lavishly administered, than a transient effect on the circulation, and by augmenting the morbid irritation of the cutaneous and mucous surfaces, and thereby confirming their congested state, they have increased the vascular exhaustion, and have enfeebled to a greater degree the action of the heart and pulse. Cold, or tepid evaporating ablutions, used according to circumstances, by diminishing the cutaneous irritation, relax the capillary congestion, the blood resumes its natural course into the vascular system, which fills up and expands, and the pulse acquires fulness and firmness. I have seen, in scarlatina, the pulse, as ablutions were employed or discontinued, become alternately full and firm, or empty and feeble. In rubeola or measles, when malignant, and confluent small-pox, the exhaustion of the vascular system, and extremely small and feeble pulse are produced in this same manner.

This principle, which I consider as of the highest importance in a practical view, when fully appreciated, has a very extensive application; and it places in a very clear light, the important fact, that a patient, in irritations of great activity, is threatened at the same instant with impending dissolution, from opposite conditions of his organs—that is, from extreme feebleness and exhaustion of the vascular circulation, and violent congestive irritation in the capillaries of the cerebral, pulmonary, or abdominal viscera, suspending their functions. It exhibits also the necessity, under those circumstances, of resorting, at the same instant, to a compound and opposing treatment, explains the objects to be attained by it, and the manner in which it is to be directed.

3d. The arteries modify the pulse, when they are themselves in a pathological state, to which they are subject, as well as the other organs of the economy. Acute inflammation, as in arteritis, causes firmness in their coats, and the pulse is then hard. The inception of ossification renders the pulse obscure, and when it is complete, the artery losing its elasticity, no longer responds to the shock communicated by the heart, and the pulse is lost. The coats of the arteries, in some instances, are softened from a species of infiltration of fluid into their interstices, which lessens their elasticity, and impairs their power of reaction.

The caliber of the artery has an influence over the pulse. I

have seen, in a case of dilatation of the heart, all the arteries preternaturally small, and which produced a remarkably small pulse. Undue enlargement of the arteries is not uncommon. The pulse, in a normal state of the circulation, is then large and full, and under excitement, is exceedingly deceptive. It appears to indicate profuse and repeated bleedings, but fails with rapidity under sanguine depletion, assuming a peculiar yielding and flaccid sensation, as though the vessel contained a gaseous or exceedingly tenuous fluid.

The pulse in many individuals is very feeble; it is scarcely discernible. They enjoy, notwithstanding, excellent health. The energy of life does not depend on the force and velocity of the vascular or direct circulation, but on the activity of the capillary circulation. Persons who are prone to obesity, have usually a small and feeble pulse. It is a common explanation of the fact, to attribute it to compression on the arteries from the accumulation of adipose matter. This is not correct; the arteries and whole vascular system in such persons, is not developed to the same extent as in others, and the vascular circulation is more inactive.

The pulse is in some instances entirely absent, without interfering with health. This circumstance occurred in the mother of Dr. S. of this city. The pulse disappeared during an attack of acute rheumatism, which did not appear to retard her recovery, and it never returned during her subsequent life. She was active in mind and body, and possessed unusual health. In no part of the body could a pulse be detected. I attended her during a part of the time of her last illness, which was an acute inflammation of the intestines, but no pulse existed. She died while I was absent from the city, and an examination was not made to elucidate the cause of this remarkable phenomenon.

A great variety of pulses have been described by writers, who have drawn between them fine lines of discrimination, and attempted to establish a particular pulse for every disease, and for every critical symptom, the occurrence of which, it was believed, could be predicted with certainty, or whose existence could be announced merely by the pulse. By the late Professor Rush, the pulse was regarded as a perfect nosometer, measuring with nearly absolute precision the state of the whole economy, and the grade and character of every morbid condition.

These exaggerated views of the importance of the pulse, originated before the circulation was discovered, and the production and nature of the pulse was known. They were subsequently maintained by erroneous opinions of the character of the circulation, its active forces, and the structure and office of the vessels. The direct circulation alone was understood, the capillary and interstitial, or parenchymatous, were not comprehended, and the heart and large arteries were believed to be the sole causes of the circulatory phenomena. But, if the doctrine of the circulation we have advocated, founded on the analysis of the organs and mechanism of this function, be adopted as correct, it must be clear, that the pretensions claimed for the pulse, as a universal diagnostic standard, must be considerably reduced. As a positive indicator, it characterizes only the action of the heart, and the degree of repletion of the vessels. The state of the capillary circulation, and consequently of the organs of the economy generally, is not manifested directly by the pulse, which, in the determination of this point, is of secondary importance. For this purpose it is to be taken in connexion with the symptoms exhibited in the disturbances of other functions, and compared with them. The heart sympathizing in most cases with the morbid affections of all the important organs, and the circulating fluid being influenced in its distribution by diseases of intensity, the pulse serves to give the value of the other symptoms, and to render their nature manifest; and it thus furnishes secondarily, and by comparison, signs indicative of the condition of the capillary circulation, and the character of the pathological state of other organs than the heart.

From this examination, it then results, that the pulse is not a general nosometer, but, as a standard of disease, is principally confined to the affections, either primitive or sympathetic, of the heart, and of the direct circulation. When, as frequently occurs, the heart and the direct circulation, from a paralyzed or quiescent state of the sympathies, do not participate in the morbid disturbances of the organs, the pulse fails entirely in presenting any positive indications of the state of those organs, or the nature of the affection.

The forces regulating the direct and the capillary circulation

being distinct, and the offices of the two being totally different, they are often placed in a state of antagonism, and exhibit phenomena of opposing characters. The pulse in these circumstances, while it faithfully marks the precise condition of the heart's action, and the state of the circulation, would betray us into fatal errors if it were consulted in order to determine the condition of other organs. In the congestions of the abdominal and thoracic viscera, the functions of these organs are oppressed with a load of blood, while the heart is barely kept in action from the extreme deficiency of that humour in the vascular system. In the close also of diseases of acute inflammations, widely diffused throughout the economy, important organs are pressing on to disorganization, demanding local depletion, and other sedative measures, with revulsive operations, while the action of the heart is fainting from debility, and requiring to be sustained by diffusible stimulation. These opposite indications cannot be revealed by the pulse. They are to be determined by other signs, and a reliance on the pulse, in the manner that has been taught by high authorities, as a guide in estimating the condition of the economy, and in directing remedial measures, will lead to wrong conclusions, and a practice often fraught with mischief.

Sect. VI. *Pathological or Abnormal state of the Circulation.*

The circulation, executed by a complex apparatus diffused throughout the organism, and entering into the mode of being of every organ, is necessarily exposed to suffer frequent and varied derangements. A large proportion of the disorders of the economy attaches to some irregularity in the circulation, either limited to particular organs, or involving, to various extent, the whole of the function. It is not the design of this section to enter into the particular details of all the diversities of functional disturbances manifested by the circulation, but merely to indicate the general character of the most important, and the causes of their production.

The circulation may be thrown into an abnormal state, 1st, by the quantity or quality of the circulating nutritive fluid; and 2d,

by a pathological condition of the various organs by which it is executed, whose offices and action have been the subject of comment in the foregoing sections.

§ 1. *Of the Blood as Affecting the Circulation.*

Plethora or hyperemia gives a force and energy to the circulation by the excessive stimulation of the blood, and fulness of the vessels, that often passes into a pathological state. The functions of the heart, of the brain, and other organs, are irregularly exercised, hæmorrhages are induced, apoplexies, and various diseases of repletion and excitation, are attendants on this state.

A reverse condition awakens also pathological phenomena not less numerous. The sudden diminution of the quantity of the blood by hæmorrhage, or venesection, produces very considerable disorders in the circulation, and disturbances in the functions of different important organs. After the first impression of exhaustion, a species of reaction ensues, which may easily be, and most probably not unfrequently is, mistaken for excitement. The action of the heart is quickened, palpitations are excited; the pulse is frequent, and exhibits often a deceptive fulness. With this state of the circulation there also frequently exists distressing and confused sounds in the head, throbbing, and other unpleasant sensations, sometimes delirium, with nervous pains in various parts similar to those of inflammation, oppression of the chest, and difficult respiration.

The feebleness of the pulse, even when full, the palor, relaxation, coolness, and moisture of the skin, the sense of exhaustion and sinking experienced by the patient, are circumstances that indicate the true character of this condition, and will guard an attentive observer against the dangerous error of mistaking it for an active inflammatory excitement, which it in part simulates, requiring depletion. Dr. Marshall Hall has written professedly on this state, the consequence of undue depletion, but he may be suspected of pushing his favourite doctrine too far, and of seeing exhaustion from depletion where it truly does not exist. The irregularity of the capillary excitement, and distribution of its circulation, such as attends on extreme congestions, in which some organs are oppressed by repletion, and the functions of others

nearly suspended by the diminution of their circulatory actions, exhibit many of the symptoms he attributes to general exhaustion from loss of blood. Some of his cases are of this character.

The deficiency of colouring matter and of fibrin in the blood, is productive of trains of symptoms precisely similar to those proceeding from excessive losses of blood. The absence of these principles is not an unfrequent occurrence in the course of chronic diseases of the digestive and respiratory organs, especially in those of the lymphatic temperament, in protracted intermittents, and occasionally takes place without any assignable cause. This defective state of the red globules is characterized, in addition to the preceding symptoms, by the bombycinous aspect of the skin, the bloodless hue of the mucous tissue of the mouth, tongue, fauces, and of the lips, disposition to anasarcous swellings, extreme lassitude, and incapacity for active exertions.

The brain and nervous system generally appear more especially to suffer, and to experience great disorder of their functions, from sudden deperditions of the sanguineous humour, and defective hematosis, when this last occurs rapidly. Paralysis has frequently been an immediate result of excessive detractions of blood. It is most probable that the disturbances of the circulatory functions induced by excessive losses of blood, are a consequence of the disorder into which the functions of the nervous system are thrown.

It is scarcely possible to explain satisfactorily the immediate cause of this disordered state of the nervous functions. Our ignorance of the nature of the nervous phenomena, and of their production, must render such attempts, if not entirely, at least for the most part, nugatory. The following rationale is proposed as an approach to a solution of the problem. A particular constitution of organs, which, in a limited range, constitutes their natural or healthy mode of being, is essential to the regular and natural exercise of their functions. A certain quantity of the sanguine nutritive humour, or oxygenated blood, definite for each organ, is indispensable to this constitution of the organs. This proportion of blood is *organic*, as much a part of the organ as its vascular or parenchymatous structure. All deviations from this proportion are an organic alteration, and necessarily are attended with an aberration of function. Now, the organic or vital actions, (see Part I. page 120,) on which depend the functional pheno-

mena, consist in molecular movements constantly existing between the molecules of the nutritive humour, or blood, and the solids. The functional phenomena, then, depend on two circumstances—1st, a definite amount of sanguine fluid in each organ; and 2d, a certain activity in the interior molecular movements of the solids and fluids of the organ. The morbid derangements of the functional phenomena connected with the circulatory movements may then be arranged in four categories or classes:—1. When the quantity of the sanguineous fluid is augmented, and the *movements* are *quickened*, the functional phenomena are executed with greater energy, and their disordered action is from excess—sthenia. 2. When the quantity is increased, and the *movements* are *diminished*, the functional phenomena are depressed or deteriorated—congestion. 3. When the amount of the organic fluid is *lessened*, and the movements are *diminished*, the functional phenomena are enfeebled, and fail, or are suspended—asthenia. 4. When the quantity is *deficient*, and the movements are *accelerated*, the functional phenomena are activated, though irregular—are in excess, but are speedily exhausted.

In a healthy or natural state of the organs, excessive losses of blood produce diminution of the organic, and with them, of the functional actions. This is manifested in intellectual and muscular feebleness, diminished sensibility, weakness of the circulation, lessened temperature, cessation of the secretions, and syncope. The phenomena belonging to the third category prevail.

But when an organ entering into the roll of the sympathies is the seat of an active irritation, which is not eradicated by the vascular depletion, the brain and nervous system, as the centre and organ of the sympathies, continue to experience the irradiation of this irritation, are excited, their organic actions, or the molecular movements of their organic fluid and solids, are quickened, and they are placed in the conditions of the fourth category—that is, their functional phenomena are violently disturbed, and rapidly exhausted. The functions of all the organs connected with the nervous system must, consequently, be equally disordered. Hence result the various symptoms, so often deceptive, that succeed to copious depletion, and excessive losses of fluids, which may be confounded with, and be mistaken for purely sthenic

symptoms, or excess of actions attended with force or power, and demanding depletory measures.

This rationale is further illustrated by the fact, that the disturbances of the nervous phenomena, induced by sanguineous losses, are temporarily relieved by a further depletion, which reduces for a short period the cerebral excitement, though, ultimately, they are highly aggravated by the proceeding. It explains also the necessity, in the treatment of this state, of keeping in check the cerebral excitement by the application of cold and sedative means, to the head, with occasionally topical depletion from the temples, or behind the ears, and revulsive excitement of the extremities, while, internally are employed diffusible stimuli, tonics, anodynes, and an analeptic regimen.

Besides the alterations of the blood noticed, others occur, which are not as easily discerned, but may exercise very considerable influence over the circulatory phenomena. In fevers of malignant, or of the adynamic and ataxic character, the blood often is of a much darker hue than in a natural state, being but partially influenced by respiration, and its plasticity is greatly diminished. The anormal condition of the blood, it is not improbable, constitutes one of the principal phenomena of these fevers; imparting to them their peculiar characters.

§ 2. *Of the Vessels as Affecting the Circulation.*

The vessels, as a conduit between the respiratory capillaries and the pulmonary vascular parenchyma, and the nutritive and secretory capillaries and vascular parenchyma, transmitting the fluids between the two, exercise a very decisive controlling influence on the regularity of the circulation. As has already been shown, they possess no active share in the circulation, but act only from their mechanical construction and physical properties, in both which respects they are most admirably adapted for the purposes of the circulation, being the most perfect hydraulical apparatus.

The inner membrane, which is in reality the true or proper vessel, is a variety of the serous tissue; it forms alone the capillaries, and is continuous with the areolar or vascular parenchyma, the last term of the circulation, in which the fluids move in every direction. From this continuity, inflammation affecting

the capillaries and parenchyma, is often extended into the vessels, and in wide-spread inflammations, occupying a large portion of the organism, the inner membrane of the vessels is found to be inflamed throughout the whole vascular system.

Inflammation of the inner membrane of the vessels, like inflammation of the serous tissues, produces effusion of plastic lymph, sometimes in considerable quantities, diminishing the caliber of the vessels, which is also, in some instances, completely obliterated. This last circumstance is of more frequent occurrence in the veins than the arteries, and occasions serious embarrassment to the circulation when it occurs in the large venous trunks.

In the arteries the inner membrane, or true vascular coat, is strengthened by an additional coat formed of the elastic fibrous tissue. The toughness and elasticity of this tissue fits it admirably for this purpose; it resists the impulse of the systole of the heart, and, as was previously explained, by its elastic reaction, continues the momentum derived from the contraction of the ventricles. When this coat is, however, the seat of a continued irritation, as it often is, and its nutrition is impaired or perverted, its physical properties become affected. Its elasticity is diminished, it loses its capacity to resist the impulse of the heart, but yields to it, and the diameter of the vessel enlarges at the point where it gives way. When the distention happens to be considerable, a break or fissure takes place, and the external or cellular coat is extended, forming a pouch. This state constitutes the true aneurism of the arteries. The pouch is not exclusively formed of the cellular coat, for this inflaming throws out numerous layers of coagulating lymph, which assist in strengthening the tumour, and prevents, for a considerable period, its final rupture.

Considerable dilatation occurs, at times, throughout the aorta from chronic affection of the fibrous coat lessening its elasticity, though without forming aneurisms. The force of the circulation is then greatly diminished.

The arteries, in some instances, are of a caliber too contracted, and the fibrous coat too unyielding, to give a free passage to the columns of blood pushed through them, especially under the operation of excitement from exercise, or other causes. The resistance the heart experiences in the propulsion of the blood, sub-

jects that organ to frequent derangement of its function, and generally induces, ultimately, its dilatation, or other alteration of structure. In one instance of this kind that fell under my notice in the Alms-house Infirmary, which terminated fatally from excessive dilatation of the ventricles, the descending aorta was not larger in diameter than the usual size of the common iliac.

The fibrous coat of the arteries is frequently denaturalized by a deposit of calcareous matter, converting it into an osseous structure. Its elasticity is entirely lost, and the vessel ceases to assist in the support of the circulation, as it can no longer react on the contained column of blood.

The cavity of the arteries is sometimes obliterated, so as to arrest entirely the passage of the blood through them. This circumstance is of more frequent occurrence in the small, than large arteries, though several cases are recorded in which it was presented in the aorta.

The middle coat of the veins is devoid of the elasticity possessed by that of the arteries. It is not necessary to their office, as they are not exposed to the impulsive action of the heart. Like the middle coat of the arteries, it is subject to softening, when it easily ruptures, and to thickening or hypertrophy, when it approaches in some respects to the fibrous tunic of the arteries.

The coats of the veins, from their distensible character, frequently yield to the pressure of the blood accumulated in them; and this circumstance is more certainly occasioned, when the middle coat has sustained a lesion by a vitiation of its nutrition, from irritation, or other cause. The enlargement of the cavities of the veins produced in this manner, is termed varices; and, lately, by Briquet, phlebectasia, of which various species exist. They are analogous to the true aneurism of the arteries. This state is most usual in the superficial veins of the lower extremities, though it has been met with in the veins of most portions of the body. A varicose condition of the veins proves an embarrassment to the local circulation, and gives origin often to serious local affections, ultimately deranging the general health.

The cavities of the veins are found in some instances very much contracted, and even entirely obliterated. This defect may proceed from adhesions of the internal membrane, a consequence

of its inflammation, or the coagulation of the blood within the vessel. The circulation of the veins is also sometimes obstructed by the formation of considerable coagula floating loosely in the veins, or having a partial adhesion.

Pus is very commonly found in the veins in the vicinity of inflamed organs; and it is this circumstance, which modern researches would appear to demonstrate in a positive manner, that is productive of many of those secondary disturbances, which have been idly explained as depending on constitutional irritation, sympathy, and other indefinite causes. It is an occurrence repeatedly verified as succeeding to surgical operations, fractures, and phlebotomy, and as attached to suppurations of the internal organs. It occurs with frequency in acute metritis, succeeding to accouchement, and in the affection of the lying-in termed phlegmasia alba dolens. In many instances it has been remarked, that pus is found, not only in the veins of the diseased structure, but in many other veins, in the parenchyma of the organs, substance of the muscles, and in the articulations. The pus thus distributed in numerous depots is not derived from absorption, at least uniformly. It is secreted by the inner membrane of the veins, into which the irritation of the parenchyma of the organs, with which it is continuous, has extended, and is thence carried along with circulatory torrent, and disseminated throughout the economy.

§ 3. *Of the Heart as Productive of a Pathological State of the Circulation.*

From the importance of the office deputed to the heart in the circulation, every departure from its normal condition, either of structure or action, is productive of more or less disorder of this function. The heart we have shown to be a mechanical power established to move the blood in masses, mechanically, between the two systems of respiratory and nutritive capillaries and parenchymatous vascular structure of the organs; and is, therefore, essential to the maintenance of their circulation, on which all the vital phenomena immediately depend. Any disability of the heart is, according to its degree, productive, consequently, of disturbance of the circulatory function in its whole extent.

The variety of tissue, the complicated arrangement, and the

diversified connexions of the heart with the organs of the economy, expose it to numerous sources of disease, and to frequent disturbance of its functional offices.

The perfect freedom of the heart's action, indispensable to its function in the circulation, is secured by the serous membrane—the pericardium—which envelopes it in a peculiar manner, placing the polished, smooth, and lubricated surfaces of this capsule in contact with each other.

Like other serous membranes, the pericardium is very susceptible of inflammatory irritation. When acute, the extreme sensibility this tissue acquires, produces an agony that nearly suspends the action of the heart, and places the patient in eminent jeopardy. The deterioration of its polished surface by the depositions of layers of plastic lymph, and the cessation of its lubricating secretion, embarrass likewise the action of the heart, and entail an impairment of its function most generally fatal in its results. This membrane is, also, the seat of a serous effusion producing a morbid collection of fluid—a form of dropsy—interfering so materially with the heart in the exercise of its office, as to prove a fatal affection.

Fibrous tissue derived from the fascia superficialis, as demonstrated by the lamented GODMAN,* is combined with serous tissue in the formation of the pericardium, and renders this capsule liable to rheumatic inflammation, so frequently transferred from the articular fibrous tissues to the heart. This translation most probably is facilitated, and is explained by the connection pointed out, more clearly elucidated by Godman, than by any preceding anatomist.

The interior lining membrane of the heart, continuous with that of the vessels, and of the same nature, is subject to the different morbid lesions indicated already as affecting it in the vessels. It is the seat of acute and chronic inflammation, of different secretions, the deposition of plastic lymph, of thickening, softening, ulceration, and induration. The action of the heart, and, consequently, the whole circulation, experience various irregularities when these defective conditions of this tissue exist. The disorders they occasion are more marked and aggravated when

* Anatomical Investigations, by J. D. Godman, M. D.

the valvular structure of the heart, formed of this membrane, happens to be the location of these affections. The regular play of their movements, which govern the order of the circulation, is then greatly interrupted, and the circulation is thrown into extreme disorder.

The auriculo-ventricular valves of the left heart, and the coronary valves at the mouth of the aorta, are those most commonly affected. It is rare to find the valves in the right heart deviating from a natural state.

The substance of the heart itself is subject to various pathological modifications. Whether the muscular fibre is affected with acute inflammation, is somewhat doubtful, and it is not yet established that a true carditis does occur. Most cases considered as such, are inflammations of the pericardium, or the internal lining membrane of the heart. Approaching to an inflammatory state, are the sanguine effusions which sometimes take place into the substance of the heart, constituting a true apoplexy of that organ.

In the mode of its *nutrition*, the heart departs, like the other organs, from its natural order. Of this character is the excessive thickening of its parietes, or *hypertrophia*, without a degeneration of its structure. This condition may prevail in the whole of the heart, or be present only in a portion. The first is a rare circumstance. I have never met with an instance of it, though cases are on record. Most commonly the left ventricle exhibits the hypertrophied state. The right ventricle is seldom the seat of this lesion, and the auricles are still more rarely affected by it. I have seen but a few cases of hypertrophy of the auricles, and then it was the left that manifested this state, and was coincident with hypertrophy of the same ventricle.

Cardiac hypertrophy is a consequence, most generally, of a light sanguine irritation, simply augmenting its nutritive actions, which may be excited in various manners. I have seen hypertrophy repeatedly to succeed rheumatic attacks, which had affected the heart by metastasis. In several instances it followed on pericarditis; chronic irritation of the stomach I have known to be its exciting cause; and in one case, attended with softening both of the heart and aorta, ending in a rupture, mental anxiety, and distress appeared to have been the originating cause.

The reverse state of the heart, or its *atrophia*, occurs, but with less frequency. The walls of the heart then become thinner, and in an extreme degree, the muscular fibres disappear entirely. In a case of sudden death, I found on examination the right ventricle having the appearance and the thickness of the pericardial capsule—it was semitransparent.

The consistency of the cardiac structure undergoes changes from a vitiation of its nutrition. It exhibits at times a morbid hardness or induration, which causes it to sound when struck like thick sole-leather, and to resist the scalpel when cut. It exhibits also various degrees of softening when it acquires unusual flaccidity, and its fibres break down with slight efforts.

The capacity of the cardiac cavities presents also different anomalies which disorder the circulation. The most usual is their *dilatation* or enlargement, and occurs most frequently in the right auricle and ventricle. It affects also the left ventricle and auricle, and some instances are recorded of all the cavities having been found unnaturally enlarged.

Dilatation of the cavities may coexist with any of the preceding conditions of the heart. Thus, it is conjoined with hypertrophy or thickening—the active aneurism of Corvisart—with atrophy or thinning—the passive aneurism of Corvisart—with induration, and with softening.

Dilatation is sometimes restricted to a limited portion of a cavity, and, then, the formation of a pouch or sac of various size opening into the cavity is a frequent result. This is analogous to the false aneurism of the arteries. I have met with only a single example of this nature. In that case the left ventricle was hypertrophied, having a pouch connected with it nearly of the size of a large hen's egg, the walls of which were also thickened, communicating with the ventricle near the apex. The existence of this pouch was suspected, and announced several months previous to the death of the patient, from the strong pulsation and impulse, detected by the stethoscope, in the left lateral region, about the fourth rib.

A common cause of dilatation is an obstruction offered to the blood in the course of the circulation, which accumulates that fluid in the heart. This sometimes arises from a morbid state of the valvular structure, sometimes from contraction in the caliber

of the arteries, and sometimes from congestions in the capillaries. This last is more common and efficient as a cause of dilatation for the right, than the left cavities. From the vicinity of the pulmonary capillaries to the heart, an obstruction to the transmission of the blood through them, is immediately communicated to the right cavities, whose parietes, being feebler than those of the left, yield to the distention they experience. On this account, acute and chronic inflammations of the lungs, of the bronchial mucous membrane, and the congestions and alterations in the pulmonary structures, impeding the passage of the blood, are so frequently attended with affections of the heart, inducing derangements of its structure. Dilatation, however, sometimes occurs from causes which it is not possible to appreciate.

The capacity of the cavities is frequently diminished, to an extent, sometimes, interfering with the regularity of the circulation. This diminution may be concurrent with a natural thickness of the parietes, with their hypertrophy, their atrophy, induration, or softening. It is most common in the ventricles, and is produced at times, especially in the right, by a thickening of the interventricular septum. It also proceeds occasionally from enlargement of the columnæ carneæ. When hypertrophy is unaccompanied with dilatation, and concentres in its progress, the cavity is necessarily contracted.

The actions of the heart are subject to be deranged from irregularities in the nervous centres, with which it is in connexion. The influence of the passions is well known, but the disorders induced in the functions of the heart, emanating from the ganglionic system, are very imperfectly appreciated. From this source are produced a great variety of cardiac disorders, many of them highly distressing, and which ultimately terminate, in some cases, if not relieved, in the production of incurable organic disease of the heart. The cardiac plexus, most probably, is the portion of the nervous organs in which the disease is located, the symptoms existing in the heart being only a functional disturbance.

To this cause are to be attributed some cases of palpitations excited by light moral impressions, by exercise, and which are spontaneously produced at times, while, at other periods, the action of the heart is perfectly natural. Some of those cases so

loosely designated angina pectoris, in which no organic disease of the heart can be detected, are of the same character. Spasms, which unquestionably affect the heart, originate in affections of that plexus.

A functional disorder of the heart, respecting which I have several times been consulted, appears to me to depend, also, on an affection of the nervous ganglionic centres connected with this organ. The action of the heart, in one case, suddenly became very feeble, and a species of lypothemia took place, accompanied with a sentiment of dying. In another case, the pulse gradually diminished in sleep, and finally nearly ceased, when the patient would awake in great distress with a similar deathly feeling. In both these cases not the least sign of disease of the heart could be detected by examination.

§ 4. *Of the Capillaries and Vascular Parenchyma, as Affecting Pathologically the Circulation.*

The capillaries appear to be formed of the inner membrane, the real vascular membrane, of the arteries and veins; and the lymphatics are formed of a tissue precisely similar. This membrane, constituting the vessels, is continuous with a similar membrane existing in the parenchyma of the organs, of which it composes a large portion arranged by its numerous septa, into a cellular or areolar form.

The vascular, or circulatory system, is not, then, to be regarded as a simple arrangement of vessels, but its principal portion is an immense serous sac or bag, having prolongations or ramifications into the different organs, and divided into innumerable cells or vacuolæ, into which the vessels open—the arteries being efferent, or bringing supplies of blood, the veins and lymphatics being afferent, or returning, the one the coloured, the other the colourless portions of the blood, from the vacuolæ or cells of the vascular parenchyma. This precise arrangement of the vascular system, cannot be positively demonstrated in the general structure of the organs, though an approach to it may be observed in the mucous membranes when prepared and examined with a microscope. In the erectile tissues, as they have been named, as the penis, clitoris, nymphæ, and nipple, and in the spleen, espe-

cially when examined in the larger animals, as the horse and the elephant, this arrangement of the vascular system is most clearly demonstrated. The diploe of the cranial bones exhibits the same disposition of the vascular system. In these organs the structure is cavernous or spongy, the cells of which are formed by the inner membrane of the vessels, and not by common cellular tissue, as was supposed by many anatomists. The cells of the erectile tissue are, in reality, as Malpighi described them, a species of vascular sinus, or dilatation of the vessels themselves. The papillæ and villi of the mucous membranes, it is ascertained, have an analogous structure. The erectile tissue, or organs, may be regarded as exhibiting, on a magnified scale, the disposition of the vascular arrangement for the circulatory or sanguine nutritive humour in the parenchyma or intimate structure of the organism.

The circulation or movement of the blood in the erectile tissue and organs, is not restricted, it is obvious, to mere vessels. It is effused out of the vessels, properly speaking, into a cavernous, spongy, and cellular structure, whence it returns again into vessels, when its transport to other organs is required, for which purpose the vessels are provided. The movements or circulation of the blood in these tissues, is accomplished, consequently, by a force acting in the tissues themselves, and not foreign to them. When they are excited, an afflux of blood is directed to them, distending their cellular or cavernous structure, and causing the phenomenon of erection. This is analogous to, and is a species of congestion. While the excitement continues, the affluxion persists, and the excess of blood producing the erection is dissipated, or reassumes the circulatory movement, only when the excitement is abated. Adopting the erectile tissue as the obvious type of the ultimate vascular arrangement, in its circulation is figured the circulation of the parenchyma of the organs generally. It is thus ascertained very directly to be effected in minute capillaries, and a spongy or cellular structure of extreme tenuity, the cellules in the coloured tissues, probably not exceeding the size of a blood globule, and in the white tissues being of a still smaller size.

The foregoing preliminaries were required to understand the nature and the mode of production of the pathological conditions of the capillary and parenchymatous circulation. In the capil-

lary and vascular parenchyma, the larger proportion of the blood is contained, and is the seat of the molecular movements, constituting the organic or vital actions, and, consequently, is interested, in some of its portions, in almost every pathological condition. Every where continuous and connected, the disturbances of a part, when possessing any intensity, are felt throughout the whole, deranging the order of the circulatory actions, imparting to them irregular, fluctuating, or undulatory movements, and overthrowing the equilibrium, that, in a normal state, prevails in the distribution of the circulatory humour amongst the organs.

In the healthy or normal state, the excitement of the organs being in every portion of the organism, in an equable ratio, adapted to the structure, properties, and functions of the organs, the capillary and parenchymatous circulation is in a just equipoise. But when an undue excitement or irritation is developed in an organ or tissue, it becomes the centre of converging and confluent movements of the capillary and parenchymatous circulation, towards which an affluxion is established, destroying the natural equilibrium in the distribution of the sanguine nutritive and excitative humour. This fluxionary movement possesses various extent, governed by the intensity of the irritation, the ascendency the organ affected holds in the economy, and degree of power in the other portions of the economy capable of resisting the attractive influence of the irritated centre of fluxion. When limited, the phenomena of local inflammations are present, which may be repeated from sympathy in other organs. It is experienced, under certain circumstances, throughout the economy, producing congestions of different intensity, and affecting different organs. The phenomena of irritation, of inflammation, and of congestion, with their consequences, are, then, of the same order, and belong entirely to the capillary and vascular parenchyma, and the capillary and parenchymatous circulation. One feature is common to these morbid states. They are attended with unnatural accumulation of blood where developed, with corresponding diminution in remoter organs, which do not partake of those conditions, the greatest deficiency existing generally in the counterpoints of the greatest excess. Thus, when the irritation and congestion are placed in the cerebral organs, the extremities are cold from the deficiency of their circulation. In the conges-

tions of the internal teguments, the external are pale, cold, and inexcitable. This unhinging of the capillary and parenchymatous circulation, is an essential character of the pathological state. The due adjustment of this circulation to the organs, and the stability of its libration throughout the economy, are the objects to be accomplished by therapeutic and remedial proceedings, either for a restoration to health, or for protection against disease.

The capillary and parenchymatous circulation is endowed with an excessive mobility. The affluxive movements just described, are excited, in particular instances, with extraordinary promptness, and wide diffusion. It is this circumstance that constitutes *paroxysmal diseases*, whatever may be their phenomena or symptoms derived from the functions of the organs affected. Simple intermittent and hectic fevers are a light form of this state, excited by feeble irritations, in which the congestive accumulation is slight, and awakens reaction, in the manner hereafter to be noticed. The reaction is a curative process, which dissipates the congestion, and diminishes, sometimes removes entirely, the primitive irritation, and, then, the paroxysm terminates, the circulatory equilibrium being restored, until renewed by the return of the local irritation.

Malignant intermittents are a more aggravated form of the same condition. The disorder of the capillary and parenchymatous circulation is more complete; the interior congestion is excessive, overwhelming the organs that are its seat, prostrating their forces, and incapacitating them from producing those irradiations into the organism, constituting reaction; while the other organs, abandoned by their circulating fluid, have their actions alarmingly enfeebled, and reduced to the lowest state of exhaustion.

The transport of the capillary and parenchymatous circulation towards a point of affluxion, is often accomplished in a rapid manner, precipitating the fluids on the organ, the seat of the attractive irritation, disordering its functions, or overwhelming it with a fatal deluge. This is the movement that has been designated by the terms raptus and molimen by the older writers, and is often accompanied with the effusion or extravasation of blood. When the raptus is directed towards the tegumentary tissues, and is attended with sanguine effusion, it constitutes the various hæ-

morrhages, but when concentrated on organs having no exterior communications, and the effusion takes place into the common cellular tissue, or interstices of the structure, then are produced the various sanguine apoplexies.

The raptus of affluxion occasions in many instances merely a temporary congestion, disordering the function of the organ; but the irritation which had excited the anormal accumulation of blood subsiding, probably by the suspension of the organic actions from the congestion itself, the blood resumes its usual course in the circulation, the congestion is dissipated, and the functions resume their natural order. The brain being the organ the subject of this affluxive raptus, we have excited, if of a mild grade, the phenomena characterizing *hysteria;* or, if of a higher grade, the production of *epilepsy.*

Should the mucous membrane of the bronchial tubes be the seat of this sudden congestive flux, the turgescence that ensues blocks up the caliber of the small bronchi, and the admission of the air into the air vesicles is interrupted or entirely prevented. Embarrassed respiration, or dyspnœa, immediately ensues as a consequence of this state, and constitutes one of the forms of *asthma.* All the excretory ducts are subject to be affected in a similar manner, and the passage of the fluids they eliminate is arrested. Acute irritation of the urethra will produce so great a turgescence of its mucous membrane, as to prevent entirely the escape of the urine, and a complete suppression is suddenly induced. This state is mistaken for spasm, and the arrest of the urine is attributed to spasmodic stricture. The same occurs in the ureters, and in the ductus choledochus in acute duodenitis, and the symptoms are attributed to the passage of renal calculi, and of gall-stones.

In all congestive and paroxysmal diseases, the essential character consists in this unhinging of the whole capillary and parenchymatous circulation, and its concentration on the organ the seat of the perturbating irritation. The treatment of these diseases must be made to repose on this basis. Its object will be, 1st, to impart force and stability to the actions of the capillary and parenchymatous structure and circulation; and, 2d, to diminish or eradicate the local irritation, the first moving power creating the disturbance. If we cannot succeed immediately in

the last object, the attainment of the first will be sufficient to arrest the paroxysmal type. This measure is accomplished by the administration of cinchona, or its preparations, of the various tonics, and other means that produce a permanent excitement of the capillary and parenchymatous circulation, or their introduction into the organism by endermic medication. It is this operation of cinchona that renders it so effectual in all paroxysmal diseases, and which have led some to attribute to it a specific property of antiperiodicity.

Inflammatory irritation, or phlogosis, is located in this same structure, and is a modification of the capillary and parenchymatous circulation. The molecular movements constituting the organic or nutritive actions, are accelerated, or acquire an augmented activity. The vitality of the inflamed part is elevated—its irritability, its sensibility, its temperature are increased. The quantity of circulating or sanguine nutritive humour in the phlogosed part is more abundant than natural, but its accumulation is never sudden, as in congestion; it occurs more gradually, and may continue, if not too intense, a considerable period without inducing the suspension of the organic actions, which takes place in congestion. Being a modification of the nutritive or organic actions, it is always productive of some change in the structure or secretions of the organ or tissue in which it occurs.

The disturbances of the circulatory functions in inflammatory irritation, are of a different character from those observed in congestive irritation. From the increase of irritability and sensibility attending it, an inflamed organ becomes a centre of irradiation, whence is transmitted into the organs eminent in the sympathies, the same order of actions—the same mode of being or condition. The heart, from the intimacy of its connexions, so frequently partaking of this state, the inflammations of the viscera, and of most other local inflammations, are productive of an acceleration of the vascular circulation, and generally of increase of its force. In congestion, the vessels being emptied by the disorder of the capillary movements and the detention of the blood in the parenchymatous structure, the action of the heart is diminished, and the vascular circulation is enfeebled. Inflammatory irritation when active, is, consequently, seldom confined to a single viscus; a constant disposition exists for its propagation; and most usually,

when excited in any of the viscera, it is transmitted to several. This circumstance modifies the influence of phlogosis or inflammation over the circulatory movements. The participation of the heart in this state, quickens and enforces the vascular circulation; the coadunition of distinct organs in this condition, multiplies the points of affluxion, counterpoising each other, and preventing the excessive accumulation on one, as occurs in congestive irritation. Inflammatory irritation is thus diffusive in its character, is excitative and perturbing of the organic actions, is not attended, in its acute stage, with a disturbance of the equilibrium of the capillary and parenchymatous circulation, to the same extent as prevails in congestion. Although the phenomena of congestion do not occur to the same extent, and as rapidly in inflammation, as in simple congestive irritation, it becomes ultimately established when the phlogosis continues in the acute form, and when it affects highly vascular organs or tissues, and is productive of the same adverse states of the capillary and parenchymatous circulation in different regions of the organism.

In treating of the pulse, the manner in which pathological states of the capillary and parenchymatous circulation modified the general vascular circulation was then described, and a repetition is here unnecessary.

CHAPTER V.

The Functions of Nutrition and Secretion; and Calorification.

The organic functions, the subjects of the preceding chapters, are merely preliminary to the more important functions of nutrition and secretion, which now present themselves in the order of our investigation. By those functions the blood is elaborated, distributed throughout the economy, and placed at the disposition of the various organs, that each may appropriate to itself the elements of its structure, or separate from the circulating fluid particular principles.

Nutrition and secretion are functions of the same order, are similar in character, and properly belong to the same category of actions. Calorification, or the production of animal heat, is attached to these processes as a necessary consequence, and may be embraced in the same discussion.

Sect. I.—*Nutrition in its Physiological State.*

Living beings proceeding from a germ, are developed, each after its special type, by the appropriation of exterior matters, previously elaborated. This appropriation necessitates a constant renewal of the structure. The different ages or periods through which the organism of animal beings passes, have each their peculiar expression in the size or state of the organs, which are thus incessantly changing. Notwithstanding the development all the solids receive in their growth, the figure is always the same. Growth is not, then, a mere addition to the extremities or circumference—an elongation and thickening of the organs—but is an entire mutation of its component parts, the type or form alone being preserved. In animals, nutrition consists not only in an appropriation of new matter to the structure, but in a removal of the elements of which it was previously composed. Animal nutrition is, consequently, a complete renewal of the animal structure—an absolute revolution is accomplished, so that in process of time, no one particle of the original composition of an animal being remains; the whole will have disappeared, and have been replaced with new elements. Animal nutrition is, then, in its physiological state, a complex process, consisting of composition and decomposition of the elemental structure of all the organism. In this respect, animal differs totally from vegetable nutrition. This last is a process of composition alone, unattended with decomposition, and the solids once formed are permanent. Portions of plants, it is true, such as the leaves, flowers, and fruit, perish and are renewed; but when they perish, they have, then, reached their maturity; the term of their existence has closed, and their fall is a real death, similar to that of individual beings.

Animal nutrition, consisting in processes of composition and decomposition, must be a molecular action, for in no other manner can composition and decomposition be accomplished except

65

by molecular actions. But all molecular actions are chemical actions. Nutrition is, then, a chemical process, regulated by chemical laws, and effected by chemical agency.

Molecular or chemical actions are not appreciable by our senses, and our knowledge of their exact nature cannot be positive. It can be acquired only by deduction. But the results of those actions are cognizable; the phenomena they create strike the senses, and are verified by them. They can be arranged in the order of their occurrence, all their relations can be established; and this is positive knowledge—the extent of science.

Chemical actions belong to matter in all its forms, whether mineral, vegetable, or animal; and all the changes in the elemental composition of bodies, whether mineral, vegetable, or animal, are the result of chemical actions. Mineral substances being principally binary compounds, their chemical actions are the simplest, and their phenomena are the most easily investigated and ascertained. Vegetable substances being ternary compounds, the chemical actions and phenomena of their elements are more complex, numerous, and difficult to investigate. Animal matter consisting of four elements, their chemical combinations must present an infinitely greater variety of phenomena, the difficulty of determining the mode, production, and nature of which, must be enhanced in the same proportion. Mineral chemistry, accordingly, has reached a high point of perfection; vegetable chemistry, as respects the analysis of the ultimate and proximate principles of vegetables, though imperfect, is in a state of rapid progression; but, in animal chemistry, very little that can be relied on has been, as yet, accomplished.

Mineral chemistry acquires certainty from the application of the synthetical as well as analytical tests for the verification of its facts. The elements of mineral bodies do not require for their specific combinations a specific apparatus, and hence the chemist can compose or decompose them in various manners. Vegetable and animal chemical elements, for their combination, and the formation of vegetable and animal substances and products, require a specific apparatus, which exists only in vegetable or animal organization, and cannot be procured or imitated by the chemist. Synthesis has necessarily been of limited application in vegetable chemistry, and can scarcely be said to have been attempted as yet

in animal chemistry, and consequently the chemical phenomena of vegetables and animals can be but imperfectly known. Nothing can be more illogical than to deny that the modifications of the material elements in the material structure of vegetables and animals, are not produced by chemical actions, merely because chemistry has not attained a perfection that leaves no difficulty to be surmounted, and chemists cannot, with the apparatus calculated for mineral chemistry, present us with the products of vegetable and animal chemistry. This demand is entirely premature. Chemistry as a science has received its form very considerably within the period of a century, yet how extensive have been its researches, how rapid its progression, how perfect its processes, how certain its results, as far as mineral bodies are concerned. In time, and probably much less distant than might be conjectured, what may not be expected from the fecundity of its resources, and the vast power of its means, in unfolding the phenomena of organized beings.

Nutrition we regard, then, as a molecular, and of consequence, chemical action, between the molecules of the animal fluids and of the animal solids. The functions of life in all organized beings are attended with an expenditure, both of power and of material; both are renewed, for which purpose a nutrition is required. The elements of the organism are derived from exterior matters, which have ceased to manifest the phenomena of life—they are dead matter. Matter endowed with life cannot be employed in the nutrition of living matter; it must first lose its vitality. The exterior matters destined for nutrition, must be subjected, in the higher animals, to certain processes in the functions heretofore described, for their conversion into the nutritive humour, or oxygenated blood—alone capable of sustaining the function of nutrition. The exterior dead matters, converted in the first instance into blood, in the second, form the solids of the economy, and then acquire a susceptibility to experience the impressions of stimulant agents, and a capacity for those movements constituting the phenomena of life. Vitality is, consequently, a product of nutrition. The organism renews, not only its own structure, but its powers or faculties, on which its phenomena depend. Life is the product of life: the vital actions are self-maintained, by creating the faculty or power which sustains themselves, and

the energy of the vital faculty is to be measured by the activity of the vital phenomena. Modifications of the nutritive actions, sufficient to impress a change on the structure, must, consequently, produce a modification in the vital faculty or power of that structure, the first cause of the vital phenomena. This fact explains the tendency of morbid states to be perpetuated, and, when they have attained a certain condition, accounts for the impossibility to cure them, leaving, as the only option, when it is practicable, the extirpation of the diseased part, by surgical means. It also exhibits the absolute necessity of preventing the confirmed establishment of morbid states of the organs, by the enforcement of an appropriate treatment in their early, especially their commencing periods.

The same fact explains the *toleration* the organs manifest, after a time, to impressions, at first highly perturbating, but which are not always the less deleterious, because they cease to provoke the disorders primarily induced. This very toleration is the result, and often the evidence, of the modification impressed on the structure, the organization of the organ, and of its vital faculty; and the direction thus imparted to the nutritive or formative acts, to the organic arrangement and forces, becomes permanent, and a restoration to the natural state and performance of the healthy function is mostly an impossibility. Organs long subjected to highly stimulant impressions, adapt themselves to that mode of existence, which is, then, their natural state of being; and if the stimulants be withdrawn, their functions are disordered to such an extent as to terminate fatally.

Nutrition, under ordinary circumstances, is a uniform process, which has been urged against its chemical character. The objection is not valid. All chemical actions are uniform while the conditions of their occurrence remain unchanged. The conditions of the nutritive acts, in a natural state, are always the same, and consequently the result is constant. The blood can be constituted of certain principles contained alone in aliment. When these are withheld, the blood loses its capacity of supplying nutrition, and the being perishes. The alimentary principles are subjected to certain definite processes, the offices of particular organs, and consequently yield invariably the same products. If these be disordered, the formation of blood is disturbed, it dege-

nerates, or entirely ceases, nutrition deteriorates, or is suspended, and organic vitiation, or death ensues. The blood is, then, in health, a fluid in its essential characters always the same, presenting the same elements to the different tissues of the organs. The actions of the organism possess an equal uniformity, and of necessity, then, from this constancy of elements, and fixity of operations, the results are invariable.

Nutrition prevails in the depths of the organism, and withdrawn from direct observation, its mode cannot be ascertained with positiveness. The gross results are alone obvious. But from these it is clearly seen to be incessant in operation, to be a molecular action, slowly, but momentarily, subjecting every organ to a radical change, to occur in the intimate structure, to be specific or definite for each organ, in a normal condition to be uniform in its productions, and to become devious and irregular in its products, under the influence of various anormal agencies, constituting a pathological state.

The seat of the nutritive actions is the parenchyma of the organs. Here arises a new difficulty in the determination of the mode of these actions. The constitution of this ultimate structure is unknown, or but imperfectly comprehended. It is generally confounded with the common cellular tissue, the common bond of the different organs. This is incorrect. Each organ, besides its common cellular tissue, possesses its specific parenchyma, of the nature, properties, and faculties of which, we are almost utterly ignorant. To obtain possession of all the ground necessary to form correct opinions on this point, we should have this knowledge—for, it is more than probable, that the innate properties or faculties of the parenchyma of the different tissues, are the immediate determining cause of the phenomena of nutrition.

To understand this proposition, a few general observations will be required. Matter is endowed by the Creator with specific properties. They are of two kinds, physical properties, and dynamic properties, or faculties. These properties give rise to all the movements of matter. Physical properties govern the movements of bodies in masses; dynamic properties cause the molecular movements of matter. The last category has been but imperfectly studied, and is as yet but little known. The dynamic properties of matter are, most probably, the cause of the pheno-

mena of caloric, light, electricity, magnetism, chemical affinity, and most of the organic phenomena. It is these properties or faculties that establish the relationship, fixed from eternity, found to exist between the integrant and constituent molecules of simple and compound bodies with each other, and with other molecules; relationships which give positive invariable phenomena whenever the molecules of bodies are placed within the sphere of activity. The affinities or concords thus established, are specific for each species of molecules, and give origin to the immense and endless phenomena of the universe, manifested in the forms, qualities, characters, and forces of material bodies. It is this law that bestows on all bodies formed by the aggregation or combination of the same, or different molecules, their specific characters and properties, physical and chemical. It prevails equally in organized bodies. Each of the immediate elements of the organism, by this law, is endowed with innate specific characters and properties, imparting to it fixed relations with other bodies, whose actions consequently give rise constantly to specific phenomena. Hence it is that the relations of exterior agents, and their actions on the organism, are not the same in all its portions, but differ in each organ or element of an organ, affecting some one in preference to another, and acting with each in a specific mode.

In the simplest of organized beings the elements of their nutrition are derived from the media in which they are plunged by a direct imbibition, without being subjected to a previous elaboration. Their organism being of a single tissue, possessing limited relations, and nourished by a single element, requires mere apposition of its nutritive element for the purposes of nutrition, each molecule exercising its affinity or election as may be required. In the beings of complex organizations, the diversified principles of their structure cannot be offered to their organs by the media in which they are placed. These principles, existing in various states of combination, require to be set free, isolated, and presented in a state susceptible of molecular actions to the molecules of the different organic tissues. These objects are attained by the various digestive processes preparing the nutritive humour, and the circulation which distributes it throughout the economy. The nutritive humour contains all the principles of

every tissue composing the organism, and the circulating apparatus, by its arrangement, places these in relation with every molecule of the organic structure, so that a direct action, analogous to the nutritive imbibition of the simpler animals, may take place between the two. The nutrition of the simplest animals is an exact type of the nutrition of the more complex animals: the manner in which it is brought into operation, constitutes the sole difference. In the simpler beings, the media in which they exist, charged with the elements of their nutrition, penetrate into, and permeate their whole structure, and the nutritive molecules and organic molecules are thus brought into immediate relation. The same is accomplished, in the more complex beings, by the mechanism of the circulatory apparatus. This apparatus we have already described,* as an immense sac, every where continuous, composed of ramifications penetrating into the intimate structure of the organs, and constituting, thus, a portion of the organic parenchyma. The nutritive humour, by the minuteness of the ramifications of the vascular parenchyma, is reduced to its constituent molecules, which are, in this manner, placed in direct relationship with the organic molecules, the specific faculties or properties of which consequently have full operation. By this arrangement every constituent tissue of the organic solids, is placed in immediate relation with the specific molecules of which it is composed, contained in the nutritive humour, which is continually renewed by new supplies derived from exterior matters, conveyed into the vascular parenchyma for distribution amongst the organs, by the arteries, and returned to receive its renovation by the veins.

That nutrition may proceed in a natural manner, certain conditions are requisite. Any of these failing, nutrition either takes a wrong direction, deteriorating the organic structure, or is suspended. These conditions are, 1st, an organized tissue endowed with its specific characters and properties, and the faculty of experiencing stimulant impressions; 2d, the impression or action of external agents or excitants, calling the excitable faculty of the organized tissue into action; 3d, oxygenized blood, or the nutritive humour containing the specific elements of the organized struc-

* See page 506.

ture; 4th, the molecular distribution of this humour, in proportions definite for each particular tissue or organ, and its incessant renewal; and lastly, the exercise of the innate faculties of the organic molecules, or organic affinity, the immediate cause of the combinations formative of the different tissues and organs of the economy.

Nutrition is thus seen to be a process intimately associated with the organic or vital actions, and so immediately depending on them, as to be identified in all their conditions. While they observe their normal degree and order, nutrition is executed in its natural mode; but when they deviate, in any organ, from that state, the nutritive processes have an equal deviation, and its structure and function suffer a corresponding detorsion from its healthy state.

Sect. II.—*Pathological State of Nutrition.*

The great principle of Brown, that vital phenomena are called into existence, and are maintained by stimuli or excitants, admitted as a truth by all correct observers, is adopted as a fundamental principle in this work. Nutrition has been shown above to be concurrent with the organic or vital phenomena, and consequently the nutritive actions are equally influenced by the impressions of stimuli or excitants. The nutrition and structure of the organs, are thus liable to be deranged by numerous causes. They may be disturbed by the actions of all the exterior agents capable of influencing the organism—of those agents essential to the production of its phenomena when acting in excess or irregular, and of those that are accidental, acting either in excess, or whose powers have no relation with the natural state of the organism.

The excitant or stimulant agents that influence vital phenomena may be divided into two classes; those that are essential to their production and maintenance, and those that are accidental, or influence them casually. The first are, caloric, the great vivifying agent of nature, indispensable to life; its collateral principle, light, nearly as influential in the production of vital phenomena; electricity, whose power is less known; oxygen, not less indispensable than caloric; aliment, drinks, the blood, and the

exercise of the functions of the organs. The second comprises those substances whose inherent powers, when they are brought in contact with the living body, exaggerate or augment the phenomena of some of its organs. Those which can be usefully employed are arranged in the classes of the materia medica as remedies; others constitute poisons, from the energy of their activity, either animal, vegetable, mineral, or miasmatic.

The stimulants of the first class are of two kinds. The one are purely stimulant or excitant, adding nothing to the structure of the organs whose actions they provoke, and at the same time exhaust. The other, while they stimulate, are reparative of the organs, by presenting to them principles or elements for assimilation, and thus sustain their powers and actions. The first influence the economy from the exterior; the last by acting on the interior of the organism into which they are introduced.

The stimulants of the second class exhibit the greatest diversities. No two of them are precisely similar, and a large proportion of them possess specific relations or affinities for particular organs, which they affect always in one manner, and in preference to other organs.

When the stimulants of the first class are in harmony with the natural or physiological state of the organism, its powers, structure, and actions, are, then, in their most perfect condition, and its functions or vital phenomena exist in the most complete order of which, by their constitution, they are susceptible.

But these agents, the immediate sustainers of life, are not fixed; they are constantly fluctuating, and the actions of the economy, and the phenomena of life are consequently exposed to frequent variations. They often exceed the grade requisite to the physiological actions, or the normal order of the vital phenomena. These become exaggerated, the molecular organic movements, excited by the essential vital stimulants, are exalted above the ordinary range—it is the phenomena of irritation that is developed. The essential stimulants of the organism, the very causes of vital phenomena, are capable of being perturbating agents, disordering those phenomena, and the condition of the organism. An elevated temperature is productive of intense inflammations of the digestive and biliary organs, and of the encephalon; artificial heat excites every form of irritation, from its lightest shade

to disorganizing inflammation. The blood, excessive in quantity and rich in quality, likewise disposes to, and often excites, acute irritations, inflammations, hæmorrhagies, &c. and its irregular distribution, from fluctuations of temperature, is the most common of the exciting causes of inflammatory disorders. Aliment and drinks not less frequently are productive of irritations in the digestive apparatus, or cerebral and other organs, and, though indispensable to the existence of the organism, thus prove the causes of its destruction. The organs of the economy are mutually excitants of each other, and an excess in the action of one will excite an irritation in another. The organs are each distinct, are special in structure, functions, powers, and relations. Though individually distinct, they are not independent, but are held in a close connexion. The functional exercise of an organ is always excitative of its organic or nutritive actions, of the vital molecular movements of its structure. The excitation of an organ from its functional offices is displayed by the brain, in the exercise of the intellectual and affective or moral faculties; by the stomach in digestion; by the muscles from exertions. If the functional acts be excessively excited, or unduly prolonged, the consequence is always an irritation of the organ, a modification of its structure out of its natural order. Now, from the connexion established between the organs, whereby is constituted the unity of the organism, this excitement of any one organ is transmitted to the organs the most intimately associated with it, and sometimes to the whole economy, and the organs, while they mutually sustain each other's actions, by this process, are productive of disease to each other.

The mutual excitement of the organs, is not clearly appreciable in the normal state, but is very strikingly manifested in disease. But even in the healthy condition it may be detected by a very slight observation. On this point we do not at present dwell, as it will be treated at large when the sympathies are the subject of investigation.

The natural agents that elicit and sustain the organic movements constituting life, it is thus seen, when they surpass the normal or physiological degree, produce perturbating actions, and an anormal or pathological state. The actions or states these agents excite, in this manner, is *irritation*. It may vary in intensity, but consists always in augmentation or excess of the

movements constituting life. But these movements are formative; they are those of the nutrition of the organs. While these movements are in their natural order, and restrained within the physiological range, the structure of the organs is in the natural order, and their functions in their healthful exercise. When irritation is established, the organic movements, the nutritive actions of the fluid and solid elements of the organism, departing from their natural order, the structure of the organs experiences a corresponding alteration. An irritation excited in any organ, consequently modifies its structure, its powers, and its functions, and their perversion is proportioned to the intensity and continuance of the irritation. Nearly all the alterations of structure to which the organs are liable, are the consequences of an irritation excited in them, and to this state unquestionably is to be referred all those changes of structure, attended with increase and irregularity of the growth, of the actions, and of the active powers of a tissue or organ.

This is a point of great practical importance. The vitiations of structure are for the most part incurable, when they have proceeded to a certain extent. They are, then, a new organization, nourished after their peculiar mode, and evolving their own powers of vitality adapted to their mode of being. They are in the condition of a graft on a tree, which, though deriving the means of life from the stock into which it is implanted, nevertheless lives after its own manner, and furnishes its peculiar products.

If the conclusion we have arrived at be correct, that irritation precedes immediately in the series of phenomena terminating in alteration or vitiation of tissue, or, in other words, is its proximate cause, then, we have it in our power, by ascertaining the nature of this phenomenon, and the methods of correcting it, to prevent the production of that condition of the tissues, and, when it has not progressed too far, to arrest its further progress and ultimately to restore the organ to a natural state. Until the annunciation of this leading principle of the physiological medicine, all the forms of altered structures were regarded as proceeding from some specific cause, as having a specific mode of action, and that they could be cured only by some specific remedy. The treatment was consequently entirely tentative and empirical, and not

based on any positive principle. This practice has been deplorably unsuccessful. The knife has been the usual resort, when applicable, and in other cases, the patient miserably perishes. No specific remedy accomplishing a cure has been discovered; no approach even to this result has been made. It is time to abandon a pursuit so fruitless and so hopeless, and, by a more rational method, seek to determine the mode of its production, and, thus, by anticipating, prevent the formation of this state, or arrest its progress in the commencing period.

Having reached the conclusion from our examination, that irritation is the proemial phenomenon of a large class of alterations of tissue, the next step in our progress, is the determination of the nature of this phenomenon, or in what it consists. Let us examine its development in parts exposed to the observation of our senses, and approached by our experimental means. When a grain of sand or other mechanical substance is lodged in the eye, an uneasy sensation is experienced, arising from the presence of a foreign body on a highly sensitive surface. This is succeeded by copious lachrymal secretion, an evidence of an excitement, or quickened action of the lachrymal gland. The eye becomes exceedingly painful, the stimulation of light intolerable, and the function of the organ is suspended. Soon follows a faint blush of the adnata, mixed with red vessels. These constantly increase, until the whole membrane, very much thickened, presents the aspect of a mass of blood, contained in a very delicate membrane. This state continuing, the cornea acquires a whitish tinge, and, finally, a complete opacity. The interior tissues ultimately are involved, ulceration, suppuration, or other destructive processes occur, and the organ is destroyed.

If a foreign body, as a splinter or thorn, be thrust deep into the skin and cellular tissue, the part becomes painful, the skin around it reddens, tumefaction occurs, its heat is augmented, the sensibility is greatly increased; in the cellular tissue effusion takes place, pus is formed, an abscess is produced, a sense of throbbing is experienced, ulceration ensues, an opening follows, and the contents escape with the foreign body.

When a heated or incandescent body is gradually approached to the skin, but not sufficiently close to destroy its vitality, the sensation of heat advances to acute pain, redness of the skin in-

stantly succeeds, and continues to acquire additional intensity, the pain is now vehement, and the sensibility increased so as to render the slightest touch distressing. Very soon the cuticle is raised into small blisters by the effusion of serum beneath it, and complete vesication is produced. Epispastics, rubefacients, and other irritants addressed to the skin, are attended with nearly analogous phenomena.

Should we select a secreting surface for the subject of observation, as the nostrils, or the mouth, and apply snuff or other irritants to the one, and pyrethrum, or similar irritants to the other, a smarting, heating sensation is experienced, followed by a copious discharge of a thin muco-serous fluid from the nose, or of saliva from the mouth; and those surfaces, when inspected, are found to be more highly coloured than is natural.

Let organs of a different character be selected, as some of the nervous organs, and let them be subjected to the impression of mere mechanical agents, as a spicula of bone, or the point of our scalpels; and, if it be the spinal marrow, we have excessive pains or tetanic spasms, according as the posterior or anterior columns are the subject of the experiment; or, if it be the cerebrum, we have loss of consciousness or aberration of the intellectual faculties. Should the irritation be made permanent, loss of muscular movements or of sensation, or epileptic convulsions, or mental alienation, stupor or coma, may ensue, and the nervous substance, or the meninges, will be found reddened, softened, indurated, thickened, or in a state of suppuration, or otherwise affected in structure.

The foregoing facts conduct us to the following conclusions:—

1st. Substances having no natural relation to the surfaces or organs to which they are applied, and those that possess a natural relation, but act with unusual force, operate in nearly a similar manner, and are both irritants.

2d. The phenomena they excite, are, increase of sensibility, of irritability, of the quantity of blood in the tissue they irritate, and of the animal temperature, with disorder of function.

3d. That these phenomena depending on the movements constituting life, their exaltation is an evidence that those movements are performed with greater energy than comports with the natural state.

4th. That the whole of these phenomena taken together constitute irritation, which is a complex term, and when employed, should be understood as describing those phenomena collectively.

5th. Irritation being an exaltation or excess of the vital movements beyond what is natural to the tissue in which it occurs, its excitation in tissues of feeble vitality elevates their phenomena in the scale of vitality, and changes the order of their functions. Thus, inflamed bone becomes sensible, irritable, vascular, and secerning, and nearly rivals in these respects mucous tissue, but is unfitted for its offices as bone in the economy. The same degree of action which would be physiological in one tissue, when it occurs in another, is highly pathological.

6th. Irritation being a modification of the nutritive actions, its development tends to a change of the structure, and an increase of the vital phenomena; and when it is suffered to persist in a confirmed state, the structure is permanently altered, and the vital phenomena are modified, so as to be adapted to the new condition of the structure. It is then incurable.

7th. That irritation, though exactly the same process, and even when excited by the same cause, gives origin to phenomena totally distinct from each other; or is manifested by very different symptoms.

The circumstances rendering the phenomena of irritation variable, and that deprive them of a fixed character, are numerous. They are modified, *a*, by the differences in its intensity, and, probably, in some respect by the nature of the exciting cause. *b*, By the functions of the organ or tissue in which it is excited. Irritation of each tissue disturbing its mode of being, will be represented by a disorder of its function or office. Thus irritation of mucous tissue, serous tissue, fibrous tissue, nervous tissue, has a series of phenomena corresponding to the character of each tissue. Most of the tissues, are, besides, compound structures, and each anatomical element is separately liable to irritation. The mucous follicles or cryptæ of the mucous membranes, or their exhalent vessels, or their vascular parenchyma, may be each, independently, in a state of irritation. Thus pustular diseases of the skin are caused by irritations of the mucous follicles, and are unaccompanied by increased exhalation, or by inflammation of the reticulated texture. Sudamina and bullæ, on the other hand,

arise from augmented exhalation beneath the cuticle, unconnected with any affection of the reticulated texture, or follicles; and erythema is a simple irritation of the reticulated texture, producing redness of the skin alone. The same irritation in the mucous membrane of the bronchiæ or trachea, will produce cough, in the stomach vomiting or spasms, in the bowels purging or colic. In similar manner, the same irritation in the cerebral organs will cause mental disorders; in the nervous apparatus of the organs of the senses, hallucinations; in the anterior or posterior columns of the spinal marrow, neuralgic pains or spasms of the muscles. *c.* The phenomena of irritation are modified by the nervous mobility, and activity of the sympathies, giving rise to congestions and reactions, constituting paroxysmal forms of disease. *d.* It is influenced by the condition of the fluids. The constitution of the fluids varies considerably. It is affected by the nature and quality of the aliment, by the purity of the air, or the contaminations infecting it, by the state of the respiratory organs and functions, by the state of the digestive organs and functions, and other causes—but, as the fluids are a portion of the structure, belong to the organization, and are a constituent in the nutritive or organic actions, their condition exercises a profound influence over all the vital phenomena, and modifies, consequently, those of irritation.

The general result of this investigation exhibits irritation, such as we understand it in its production and nature, to be the proximate phenomenon of a great diversity of pathological affections, which, however, differ only in symptoms; and that it is also the proximate phenomenon of all the morbid alterations of structure attended with augmentation of the nutritive actions.

Irritation inducing a pathological state of the nutritive function, produces various pathological conditions of the tissues and organs. They may be classed in three series. 1. It disturbs the distribution and order of the sanguine fluid element of the tissues. 2. It affects the composition or mode of structure of the tissues. 3. It occasions the deposition of anormal products in the interstices of the tissues, and thus vitiates their nature.

First series.—Irritation attracts, in a manner that cannot be explained, the nutritive or circulating humour, into the tissue wherein it is excited. *Ubi stimulus ibi irritatio; ubi irritatio ibi fluxus.* This axiom, the result of the earliest observation,

has been confirmed in all succeeding periods, and is verified by daily experience. The vascular system is a common reservoir of supply, from which each organ derives the fluid required for the support of its actions. A certain quantity of this fluid or humour is proper to each tissue; and some tissues admit, in a natural state, only certain principles of this fluid of which they are formed, and reject others; as the white tissues, that receive only colourless blood. The quantity of fluid proper to the tissue may be termed organic; it is a component part of the organ, and a variation from it denaturalizes the structure. Irritation in reference to the circulation of the fluid element of the tissues, occasions two pathological modifications; *a*, congestion; *b*, inflammation.

a. Congestion.—Excited in highly vascular and irritable tissues, irritation often causes a sudden raptus or rush of blood into them, and their vascular parenchyma is gorged and excessively over-distended with this fluid. The organ is sometimes inundated to such an extent as to be disorganized in structure, constituting apoplexies, or the fluid escapes; when the effusion is on a surface communicating exteriorly, it causes hæmorrhagies. In simple congestion, unattended with effusion, the excess of blood arrests the molecular or organic movements, a remora takes place in the circulation of the part, its functions are lost, and its vitality enfeebled.

b. Inflammation.—Irritation exalted to a certain point, constitutes inflammation. In this pathological state, the sum of the organic fluids in the tissue is augmented; a far larger proportion of blood than is natural is contained in it; hence the redness and the tumefaction which attends on inflammation. It differs from congestion in the greater activity of the organic actions or molecular movements, which, in inflammation, are carried to their highest intensity. From this cause arises the increase of the temperature of inflamed parts, the higher degree of sensibility and of irritability: the augmentation of vital power, and the disorder of functions, exhibits this excess of action and unnatural energy. Inflammation, necessarily, by the derangement of the nutritive actions, modifies always the structure. When it is of feeble degree the change is slow, but in its acute form, unless arrested, it ends in the destruction of the organ. The effects produced by inflammation are not uniform, and the differences observed have been constituted distinct kinds of inflammation. This subject will,

however, be more fully examined in the division appropriated to pathology.

Second series.—The constitution of the tissues undergoes various mutations, and even transformations, from the action of irritation modifying the function of nutrition. The organic molecules or atoms are arranged in each particular tissue by the processes of nutrition, which have been shown to be a composition and decomposition of the structure. Irritation disturbing the order of these processes occasions different lesions of structure, which may be placed in four classes.

1*st Class.*—The structure exceeding the natural type from excess of its organic molecules; or being inferior to it, from their deficiency. The first of these states is hypertrophy, the last atrophy of the structure.

a. In hypertrophy the natural order of the molecules in the structure is observed; the nature of the structure is not altered; it is merely developed in excess. The process of composition is too active, and the equilibrium existing between it and decomposition is lost. It is almost uniformly the consequence of a low degree of irritation, such as is frequently induced by too frequent exercise of an organ, or its constant over-stimulation.

Hypertrophy was first observed in the muscular tissue, and especially as occurring in the heart. Attention was drawn towards it from the disorder it occasions in the functions of this organ. It is not, however, limited to the muscular tissue, as was supposed: more accurate observations and the attentive cultivation of pathological anatomy, at the present period, have demonstrated its existence in every tissue and organ of the economy. In the compound organs, hypertrophy is often limited to a single tissue of the structure. In the general tissues it frequently occurs in a very limited portion, as in fungus hæmatodes, which is hypertrophy of the vascular parenchyma, &c.

b. Atrophy is the reverse of the preceding state. Decomposition prevails over composition in the process of nutrition, and the anatomical texture is degraded; the organ does not receive its full development, and is incapable of exercising its functions. It is somewhat doubtful whether this state is an effect of irritation: it has been denied. In some cases it has appeared to me to be connected, unquestionably, with irritation, and to be its di-

rect result. The cases I allude to were patients attacked with rheumatism of the capsular ligaments. The disease manifested great severity, and on its decline the ligaments seemed to disappear, and the joints, in consequence, were dislocated by the contractions of the muscles. A terrible case of this kind is, at present, in the city. The hands at the wrists, and the fingers at each joint, are dislocated, in a manner to form different angles with each other: the feet are in a similar condition. The testicle, also, I have seen to disappear by a gradual absorption after an attack of acute inflammation.

Atrophy, as well as hypertrophy, occurs, however, from other causes than irritation. Whatever occasions a diminution in the quantity of blood usually received by an organ, or that diminishes the activity of its molecular movements, will cause atrophy of that organ. The suspending of the function of an organ, produces its atrophy by depriving it of the excitement of its exercise, and the consequent diminution of its circulation and nutritive process. An organ rendered useless to the economy ceases to be nourished, and is atrophied. This occurs with several organs employed in intra-uterine life, but which are not required after birth, as the thymus gland, capsulæ renales, left lobe of the liver, &c. Other organs, as the testicles, ovaries, and uterus, remain, as it were, in a rudimental state, until their services are required, when they suddenly acquire their full development, and when no longer of utility, they wither or become atrophied. A limb condemned to absolute rest, diminishes in size, and its nutrition is adapted to the degradation of its office—it is in a state of atrophy.

Atrophy, like hypertrophy, may be limited to a single element of a compound tissue, it may occupy a single tissue or organ, or a portion only; and it sometimes affects the whole of a tissue in the economy. This last occurs in those instances of extreme emaciation, when the individual appears a mere animated skeleton without apparent disorder of any important viscera or functions. Calvin Edson, who was exhibited as a living skeleton, I take to have been a case of this nature. As well as I could determine, his emaciation proceeded entirely from the disappearance from his organs of the cellular tissue. The muscular fibres were unaffected, and hence he experienced but little diminution in his physical strength.

2d Class.—The structure altered in its consistency, or disorganized by the resorbing of its molecules, producing solution of its continuity.

This class of lesions offers four different species: *a*, induration; *b*, softening; *c*, ulceration; *d*, gangrene.

a. Induration.—Every tissue possesses its proper consistency, derived from the proportion and nature of its solid, compared with its fluid elements. The consistency of the tissues is not the same in all ages or periods of the body. The first germ is almost entirely fluid, and all the tissues in their earliest periods are semi-fluid. They acquire consistency as they are developed, and continue, while advancing in age, to acquire additional firmness. This arises from the predominance of the solid over the fluid elements, in the processes of nutrition, and is the gradual decay of the organs, and the natural death of the animal machine. Old age exhibits the imbecility of infancy, but from the very reverse condition of the organs. In infancy the organs are soft and the fluids in excess; in old age the organs are firm and rigid, and the solid matter predominates.

The organs, however, acquire a consistency which is unnatural, of premature occurrence, and the consequence of disease. This pathological state is what is meant by *induration*. The most common cause of induration of the tissues, is, unquestionably, irritation, a morbid disturbance of the function of nutrition, and of the parenchymatous circulation. We have the evidences of this fact in the signs during life, and autopsy furnishes a conclusive testimony of its correctness. It frequently occurs that after complete induration has been induced by irritation, the diminution of the vitality of the indurated tissue from the excess of its solid elements, diminishes its capacity of being irritated; the irritation disappears, the tissue then loses its vascular aspect and red colour, becomes of a gray, pale, or whitish hue, and is, then, supposed to have been formed independent of irritation. Induration of the white tissues, is often produced by irritation limited entirely to the lymphatic capillaries, especially in individuals of the lymphatic temperament, without involving the red capillaries and red circulation; and, consequently, the phenomena which are too generally regarded as the characteristics of irritation, are not manifested. Those who deny the produc-

tion of induration from irritation, have founded their objections solely on the absence, in some cases, of the signs of *inflammation*; but inflammation is only one state of sanguine irritation, and has no resemblance whatever to lymphatic irritation. The objection arises in error, and is devoid of validity.

When a tissue is indurated it acquires a density much greater than is natural to it, and resists with much greater firmness all mechanical injuries, as tearing, cutting, &c.; divided by the scalpel, it often grits beneath the blade, and yields a particular sound when struck. It exhibits a variety of aspects, as to colour, volume, and form, which are often different from the natural state, though frequently, especially in the nervous and muscular tissues, no other deviation is observed than increase of consistency.

Every tissue is susceptible of induration, and in the complex organs, it frequently occurs in one only of the textular elements. It is not a result of acute inflammation, but a product of chronic irritation. Induration, especially when united to hypertrophy of the cellular and fibrous tissues, is commonly designated by the term schirrus. It often is the percursor of cancer, which is developed when inflammation becomes excited in a tissue that has undergone what is termed white induration or schirrus.

The tissues often acquire an increase of consistency from the nature of the fluids which penetrate them. They are then said to be indurated; it is, however, different from proper induration, which consists in an excess of the solid molecules of the tissue. The cellular tissue is often indurated by the presence of an albuminous fluid in its meshes, strongly disposed to coagulate. I have met with this state in dropsical cases, accompanying anasarca: it is also the scleroma of new-born infants.

b. Softening.—This is the reverse condition of the preceding state of the tissues; and, like it, is a product of irritation. The result of irritation, it is difficult to calculate, as we do not know all its modifying causes. It creates a disorder in the mode of the nutritive actions; it gives to them a direction, which sometimes continues even after the cessation of the irritation that had first given the unnatural impulsion.

The consistency of the tissues differs considerably in different individuals. In some they possess a very striking flaccidity widely different from the firm, dense fibre of others. This state

attaches to the temperament of the individual, and will hereafter be noticed. The tissues vary also in their consistency in different periods. They are often very flaccid and soft after acute, and in the progress of some chronic diseases, and resume their former firmness on a restoration to health. This is observed in the leucophlegmatic, and arises from the loss of fibrin and red globules, and the superabundance of albuminous and serous fluids in the constitution of the organs. It is not, however, to this species of flaccidity that the term softening is applied.

The pathological state of the anatomical elements, termed softening, was scarcely observed by the older anatomists, and it is entirely the researches of modern investigators, that have revealed its existence and demonstrated its character.

Softening of the tissues consists in the diminution of their consistency, from a loss of their molecular aggregation. It is a consequence of disorder in the nutritive processes, and modification or loss of the vital affinity, accomplishing the composition of the tissues. Seldom do we find it generally pervading a tissue, but more frequently, it is confined to a limited portion. In the parenchymatous organs, it often involves nearly the whole structure. I have seen repeatedly the spleen a mere pulpy mass; in several instances I have met with an entire lobe of a lung semi-fluid, and a large part of the liver equally melted down to a diffluent consistency.

In the compound textures it is not uncommon to find a single element softened, while the others retain their normal consistency. This occurrence presents itself frequently in the alimentary canal; the sub-mucous cellular tissue having entirely lost its cohesion. The mucous membrane is then found detached, or so loosened that it may be peeled off with the slightest effort.

Softening, since it first attracted the attention of anatomico-pathologists, has been detected in every tissue and organ of the economy. It is not peculiar to any one.

The degrees of softening in the different tissues are not uniform: they offer three states. 1. A softening of the tissue which still retains some solidity, but tears and breaks with the greatest ease. This is the only state in which it can exist in the heart. 2. The solidity of the tissue has totally disappeared, the organization of the structure is destroyed, and a mere pulpy mass or semi-

liquid substance remains. 3. The tissue totally disorganized, presents merely some shreds, the indications of its former existence. This is seen in cases of perforations of the membranous organs.

Softening of the tissues may be complicated with other alterations of the structure. It accompanies sometimes, though rarely, hypertrophy; it is more frequently the companion of atrophy, though in most instances the organ has suffered no change in its volume. Softening I have suspected to supervene, in some instances on induration, when a second irritation has been excited in the tissue that had undergone that alteration.

The colouring of softened tissues is not always the same. In the highly vascular organs in which sanguine irritation or inflammation is most easily excited, the softened tissue has more or less of a red colour. In the white tissues, as the nervous medullary substance, this circumstance is often absent. More frequently it is of a dirty yellow or brown, though often it is reddened and intermixed with the colouring matter of the blood, as I witnessed but a few days past, in a patient in the Alms-house. The colour is often in its normal state, having undergone no change; and in some instances, the colour is whiter than natural.

The most common, if not the uniform cause of softening of the tissues is irritation, imparting a wrong direction to the processes of nutrition. It is not absolutely necessary that irritation should acquire the intensity of acute inflammation for the production of this state of the structure. I have not as yet met with a single case of softening of the tissues, either in the infirmary department of the Alms-house, or in private practice, that did not manifest the most unequivocal signs of active irritation in the affected organs, in the early stages of the disease. In some of these cases, the softening of the organs has been announced as having taken place in the progress of the case; an opinion verified by autopsy. It is a result of acute and sub-acute irritation more frequently than of chronic.

It will not be asserted positively that irritation is the exclusive cause of softening. It may possibly be a result of a deficiency of nutritive principles in the blood, from a deficient or defective alimentation; but even then, that it occurs absolutely independent of all irritation, is by no means to be admitted. An impoverished quality

of the sanguine nutritive humour, may predispose to this effect, and cause it to succeed with more rapidity and certainty to a feeble irritation. If this state depended on the blood alone, the softening, instead of being limited, as it usually is, to a very restricted portion of a tissue, would occupy its whole extent.

Those who question the uniform production of softening by irritation, rely for their opinion on the absence, in *some cases*, of the physical signs of *acute inflammation.* This objection, it is scarcely necessary to repeat, possesses no validity, as it confounds things that are distinct. Irritation and inflammation are not the same; the signs of inflammation are epi-phenomena superadded to those of irritation; and the irritation of the white tissues, lymphatic irritation, never manifests the signs belonging to inflammation.

Softening of the bones, or osteo-malaxcy, when general, is an exception to this remark. It appears to be due to a general vitiation of the nutritive, and probably of the digestive functions. This disease is so very rare in this country, that an example of it has never been presented to me, either in public or private practice, and I cannot speak of it in positive terms; but from the description of writers, it has no analogy with the softening of the tissues treated in the preceding remarks.

c. Ulceration.—Ulceration is a vitiation of the nutritive processes, producing a solution of continuity, from a resorbing of the constituent molecules of the tissue. It is always a result of inflammation, acute or chronic. Simple irritation, probably, never gives rise to this variety of disorganization. The inflammation exciting to ulceration, may arise from an external cause, as the presence of a foreign body lodged in a tissue, or may be developed spontaneously. The process effecting ulceration, or the resorbing of the organic molecules, is not known; we are capable only of ascertaining some of the preceding and concomitant phenomena. Its object appears to be frequently salutary, or preservative of the general economy by a sacrifice of a part. The provision of this process, enables the organism to free itself from the presence of substances, disturbing the order and harmony of its functions. A foreign body, acting as an irritant embedded in the tissues, is removed by this process. The tissue melts, as it were, around it, by the secretion of fluids and formation of pus,

ulceration opens a passage to a surface in communication with the exterior, and the offending substance is discharged. It is observed, that tetanus most frequently succeeds to injuries, in which very small bodies become lodged in the tissues, as a minute splinter or other substance, and which do not prevent the healing of the wound. The irritation of these bodies is not sufficient to excite an inflammation adequate to cause suppuration and ulceration, and consequently they remain buried in the tissues. Though incapable of exciting in the vascular parenchyma an irritation competent to the production of the suppuratory and ulcerative processes, they maintain a constant irritation in the nervous expansion or fibrils, that ultimately induce in the nervous centres to which it is irradiated, the most formidable and fatal disturbances. Ulceration is protective from this danger, and by exciting suppuration and ulceration in wounds of this character, by preventing their cicatrization, and maintaining them an open and discharging ulcer by irritating dressings, we remove the danger of tetanus, and occasionally succeed in preventing its development, when commencing symptoms have appeared. By this same mechanism also, the organism is relieved from the presence of morbid products deposited in the interstices of the tissues, and of tissues transformed and degenerated in their structure, both of which produce in the economy the effects and disturbances of foreign bodies. In this manner tubercles are discharged from the lungs, and indurated glands and follicles are destroyed and removed.

Though inflammation is essential to ulceration, other circumstances combine to facilitate its production. The most common causes giving an unnatural predisposition to ulceration, are anormal or vitiated conditions of the nutritive humour or the blood. The crasis or constitution of the blood is modified in a variety of modes. Improper nutriment, aliment deficient of the nutritive elements, or containing positive morbific principles, so influences the constitution of the solids, as to diminish the affinity and aggregation of their constituent molecules. The slightest inflammation, then, terminates rapidly in ulceration. This modification occurs from a diet exclusively of salted meat, or of crude vegetables, as cabbage, greens, or sugar; it occurs when carnivorous animals are fed solely on vegetables, or graminivorous animals on meat; and is produced when spurred or diseased rye constitutes

the principal portion of the food. Chronic diseases that exercise a deteriorating influence over the functions of respiration and digestion often occasion, though slowly, the same result; hence the disposition to ulceration in the mucous tissues of patients affected with phthisis pulmonalis, so readily excited by irritants applied to those surfaces. The same condition occurs too in many fevers of a protracted type, when the secretions and excretions have been suspended, or are irregular, and functions of importance have been disordered, causing the extensive sloughing of the points on which the body rests, and gangrene from blisters. Some mephitic exhalations most probably exercise a similar deleterious influence on the blood.

d. Gangrene.—This state is a result most commonly proceeding from inflammation, though it may be produced by other causes. It is the death and decomposition of a greater or less extent of a tissue, or of several tissues at the same time. The manner in which inflammation occasions gangrene is not well understood. Gangrene is a consequence of the interruption or suspension of the circulation. The uninterrupted supply of oxygenated blood, is one of the conditions of the organic actions, is essential to the performance of the molecular actions in the organs constituting nutrition. When an artery supplying a part with blood is tied, or its calibre is obliterated, or a part is subjected for some time to a compression sufficient to destroy its circulation, gangrene ensues. The same result occurs when agents exert an influence destructive of the molecular arrangement of the tissues, and the affinity which determines organization. Such are violent heat, extreme cold productive of the congelation of the tissues, the concentrated acids, &c. Inflammation, when it terminates in gangrene, appears to produce nearly analogous effects. The activity of the circulation of the inflamed part gradually declines with the augmentation of the congestion, oxygenated blood ceases to penetrate the tissues, and this condition, indispensable for the persistance of the organic or nutritive actions, being withdrawn, they terminate, and the vital forces, no longer created, become extinct in that part. Gangrene is always observed to commence in the centre of the inflamed circle, where the inflammation was first developed, where it existed with greatest force, and the congestion is most intense.

When a tissue is struck with gangrene, this is made manifest in the first instance, by the diminution of the animal temperature, the loss of sensibility, and the cessation of all movements. The character of the organization is entirely changed, the natural colour of the tissue disappears, and it assumes a gray, livid, slate-coloured, or blackish hue, attended with softening, or, in some cases, a dryness of the tissues, and finally there are disengaged offensively fetid gases, from a species of putrid fermentation decomposing the elements of the structure.

Gangrene sometimes occurs in a spontaneous manner, especially in aged people, when it is termed senile gangrene. In many of these cases it is due to an inflammation and obstruction of the principal arteries of a limb. There are some instances, however, in which the symptoms appear of a different character.

Certain states of the economy dispose to gangrene. These are attended with more or less deterioration in the crasis of the blood and the constitution of the solids. They are then incapable of maintaining the molecular movements, when augmented considerably by excitant applications, or to repair injuries to the structure, and gangrene ensues.

3d Class. Transformations of Tissues.—Amongst the frequent deviations experienced by the processes of nutrition, arising from irritation, is their being misplaced. In this case, the process of nutrition itself may be said to be in a natural order, but is not natural to the tissue where it occurs. The consequence of this state is the production of accidental tissues, natural themselves, or analogous to tissues entering into the constitution of the animal organism, yet which do not belong to the constitution of the particular organ in which they are developed: for that organ, they are a morbid product, subversive of its function, and incompatible with its mode of being. The most correct designation for this pathological condition of the tissues is transformation.

The first rudiment of every organ, as of the embryon itself, is a mere web of cellular tissue, but this gradually disappears with the production of other elements. Transformation of the tissues, is, then, a natural process, and most of them, before they reach their perfect state, have existed previously as some other tissue. Transformation of the tissues is to be traced in the series of animals, where we find one tissue replacing or substituted for an-

other, adapted to the especial want of the animal. The osseous and nervous tissues offer striking exemplifications. The process, though physiological, occurring out of its order and place, causes a pathological condition of the tissues.

The tissues are not indiscriminately transformed into each other, but observe a certain relation and order in this respect. The cellular tissue, the common rudimentary element of all the organs, is the most frequent subject of transformation, and may be transformed by a pathological process, into every other tissue. It never, however, passes into nervous tissue, except to replace it in the points where it previously had existed, and to supply the loss of substance; it is in this manner that divided and excised nerves are reproduced.

The other tissues, as the fibrous, cartilaginous, muscular, mucous, cutaneous, are less susceptible of transformations than the cellular, and their changes are the same as they present in the embryon state, or in the series of animals. Muscular may become fibrous tissue, cartilaginous become osseous, but neither be metamorphosed into serous or mucous tissue. Mucous and cutaneous tissues are mutually transformed into each other, but not into cartilaginous, muscular, or osseous tissues.

In the organs of complicated structure composed of various tissues, the cellular tissue interposed between their layers or entering into their parenchyma, often undergoes transformation, while the proper tissue of the organ remains in a normal state, or as sometimes happens, becomes atrophied. I have seen, in one instance, the sub-mucous cellular tissue of the stomach converted into cartilage half an inch in thickness, the mucous membrane being but slightly affected. Fibrous productions are formed in the organs in the same manner, by the transformation of the cellular tissue entering into their composition. The accidental fibrous tissue thus produced, frequently is the seat itself of a morbid irritation, giving rise to new alterations, and ultimately looses entirely its character. This transformation is one of the morbid conditions of the structure attributed to cancers. Fibrous tumours forming on nerves, as reported by Sir E. Home, and frequently met with in the uterus and other organs, are transformations of the cellular tissue entering into the composition of those organs.

The physiological transformations of the tissues occurring in the embryon state, and in the animal series, are unfolded by laws the production of which are unknown. These changes are always calculated for the advantage of the individual.

Pathological transformations, in far the greater number of instances, are the consequence of irritation, impressing a wrong direction on the nutritive processes. We are yet too much unacquainted with the exact nature of these processes, to be able to explain the diversity of character they assume from the impress of irritations.

4th Class. Degeneration of the Tissues, attended with Morbid Productions.—The tissues, we have just seen, from a misplaced nutrition, are subject to transformations, passing into each other. Tissues thus occurring out of their place, as a product of disease, are named *accidental tissues with analogies,* and might be termed *natural accidental tissues.* This is not the limit of their metamorphosis. They are converted into substances devoid of all analogy with any part of the normal structure. These morbid productions have been called *accidental tissues without analogies.* They are perfect heteroclytes, and may be named *unnatural or heteroclytical accidental productions.*

Confusion has resulted from not discriminating clearly the transformations of the tissues from their degenerations. This last may be restricted to two forms—*a, tubercles,* and, *b, schirrus or carcinoma;* and depend on morbid productions deposited in the intertexture or meshes of the tissues. They differ, consequently, entirely from the transformations of the tissues, as in degeneration the tissue is not alone affected, but is accompanied by the presence of the foreign morbid product in its structure.

The organs most liable to degeneration are composed of a compounded structure, into which enter several elementary tissues. All of these are not indiscriminately the first seat of the morbid alteration, or are susceptible of it in the first instance. Degeneration commences in the cellular tissue, or the vascular parenchyma circulating lymph or the colourless portion of the blood. The morbid production takes its origin in this tissue, and by its progressive increase, produces atrophy or destruction of the other elements, entirely metamorphosing the character of the structure.

a. Tubercles.—This name has been applied to a great number of tumours of various kinds, especially those existing in the lungs. The term, since the works of Bayle and Laennec, is taken in a more restricted and definite meaning. It is now appropriated exclusively to a matter formed in the interior, or on the surface of the organs, of a yellowish-white colour, opaque, having a varying consistency, but always friable, more or less rounded, and of different size, and devoid of all trace of organization or texture.

The most common seat of tubercles is the pulmonary organs, but they are not confined solely to this structure. They are developed in every organ and texture. It is not easy to prove in an absolute manner, that either the cellular tissue, or, what is more probable, the lymphatic vascular tissue, both which are components in different proportions of every parenchyma, is the proper seat of the tubercular secretion. Strong grounds, however, may be adduced in support of the doctrine, and hence it is that individuals of the lymphatic temperament, in whom the cellular tissue and the lymphatic fluids are most abundant, are those most obnoxious to the tubercular deposition in their tissues. On the contrary, those who are endowed with the sanguine temperament in a high degree, and whose blood is rich in fibrin and red cruor, rarely, if ever, exhibit tubercles in their lungs or other organs, though long suffering under the very same causes that develope them with fatal certainty in the lymphatic.

The tubercle does not present the same characters precisely in all its periods. Bayle and Laennec describe it in its origin as a grayish and demi-transparent granulation, subsequently becoming opaque, and finally, softening from the centre to the circumference. Both these writers have evidently laboured under an error, as has been shown by Andral. The granular appearance of the pulmonary tissue resulting from partial pneumonies, an appearance produced by the retraction of the healthy pulmonary vesicles after an incision, leaving the inflamed and indurated vesicles projecting from the surface, they have mistaken for tubercles in their rudimental state. Baron has conjectured that tubercles commence as hydatids, or minute serous cysts, but this opinion is unsustained by any observations deserving of confidence. The views of Cruveilhier on this point merit the most attention, are supported by the best evidence, and

are now generally adopted by observers of highest repute. The original form of the tubercle, he asserts, is liquid, and is a species of pus; but he has most singularly limited its production to the pulmonary vesicles. The formation of pus may occur in most of the tissues, and the restriction he assigns to the tubercle is not verified in nature. The liquid, the primary form of the tubercle, is different from the common pus of inflammation, and is most probably a modification of lymph. Tubercles, when once formed, almost invariably continue to increase by successive depositions, and often attain to the size of a large orange, especially in the lungs. They are always softest in the centre, which is frequently semifluid. Bayle, Laennec, and Louis, regard them as organized, and endowed with vitality; and the increase and softening of tubercles as actions of their own. This opinion is a pure hypothesis, and is entirely abandoned by sound pathologists.

Tubercles are generally surrounded by a species of membrane, in which they appear to be contained. This apparent membrane is nothing more than condensed cellular tissue, formed by the pressure of the tuberculous deposition, precisely in the manner that a similar membrane is formed around foreign bodies of any kind, lodged in the tissues.

Tubercles undergo two species of alterations, the purulent or softening, and the cretaceous or calcareous. The first is the most common. The mode of softening of tubercles is not positively established. Undoubtedly it is foreign to the tubercles themselves. I am disposed to believe it is effected in a manner analogous to the mode nature adopts for the softening of coagula of blood effused into the brain in apoplexy. The tuberculous matter is a product of irritation affecting the lymphatic vascular tissue; it is concreted lymphatic pus secreted into the meshes of the cellular tissue, or what may be termed the lymphatic structure. The tuberculous deposition, like the coagulum of blood in the brain, acts as an irritant on the surrounding structure, and excites *sanguine irritation*, and often inflammation, causing an exhalation of a perspiratory or serous fluid, sometimes proper pus, which dissolves the tuberculous matter, as it does the coagulated blood in the cerebral organ. This last, in apoplexy, is then absorbed, and the patient recovers. The tuberculous matter, when liquified, is placed in a condition susceptible of being evacuated, and is

often discharged, leaving behind a considerable cavity, usually designated a *cavern*. This is the only manner in which tubercles can be cured.

The cretaceous transformation of tuberculous matter is occasionally observed; it becomes a mass of a chalky consistency. When this occurs its farther formation ceases, and it exercises no injurious influence on the economy.

As the result of the most correct observations, we may conclude, 1st, that tubercles, in their origin, are fluid; 2d, that they are a species of pus, formed of the lymphatic fluids, by the process of irritation, in the tissues nourished by lymph or white blood; 3d, that they solidify from the circumference towards the centre, which is the cause of the greater softness of that part in most tubercles; and 4th, they are softened or dissolved by the secretion of a serous, or sero-purulent fluid, resulting from sanguine irritation or inflammation awakened by their presence in the surrounding tissues nourished with red blood.

The most important point to be determined in the history of tubercles, is the immediate cause of their formation, for on a knowledge of this depends, in a great measure, the method of treating them. Various opinions have been promulgated on this subject. Bayle, Laennec, Louis, and Gendrin, regard them as entirely independent of any local affection, and as infiltrated or deposited from the blood into the tissues, without the tissues participating in their production. This doctrine can be viewed in no other light than a mere hypothesis, and one too very unphilosophical. They appear to have been led to this conclusion from an imbibed opinion, that inflammation is the only modification of the actions of the tissues; and as tubercles are found without the signs of inflammation in some cases, they inferred those productions were independent of the tissues. But inflammation is only one of the forms of the morbid actions assumed by the tissues. Grades of irritation of a less degree than inflammation do exist, and vitiate the structure; and it may be exclusively limited to a single element of a parenchyma. An ignorance of this fact has led to numerous errors of observation on the part of those writers, and has often involved them in very false reasoning.

The most usual exciting cause of pulmonary tubercles, it is in the experience of every one, are neglected catarrhs, and pneumo-

nites of a feeble grade. Yet these are diseases of irritation. Besides, M. Cruveilhier has decided the question, in producing tubercles in the lungs of dogs by injecting mercury into the trachea. The globules of mercury lodged in the pulmonary vesicles, caused the secretion of tuberculous matter by the irritation they excited.

It is not every irritation that will suffice for the production of tubercles. I have seen many instances of chronic bronchitis persisting for years without the formation of tubercles in the lungs. The same occurs in chronic pneumonia. Many individuals labour a considerable period under this disease, and the lungs suffer great deterioration, but no appearance of a tubercle is to be discerned. In other individuals, on the contrary, slight catarrhs, if permitted to continue for even a short time, or light pneumonic irritation, develope tubercles with rapidity, and throw the patient into phthisis.

It is not, then, irritation exclusively to which tubercles owe their production. Other circumstances must be combined with it. These belong to the individual, and are to be found in the constitution of his organs, and the elements of his fluids—the source of the products, natural or anormal, of the organism. Those who manifest the absence of all tendency to tubercular formation, are endowed with the sanguine temperament and hepatic predominancy. They possess blood rich in fibrin, and in colouring matter. Their chests are usually large and full, their complexion dark, flesh firm, muscles well-marked and highly coloured: their diseases are those of sanguine irritation and inflammation.

On the contrary, those who are noted for their proneness to tubercular productions, are marked by the characters of the lymphatic, and sometimes nervous temperaments. They possess contracted chests, round limbs, soft flesh, light complexions, delicate skin—red blood and fibrin are deficient in them—the lymphatic fluids abound, and the white tissues predominate in their organs. An impoverishment of the fluids from defective alimentation, and a residence in a vitiated, humid atmosphere, with abstraction of the influence of light, by depriving the blood of its cruor, and generating excess of lymph, are the most certain of the predisposing causes of this degeneration.

b. Scirrus and Carcinoma.—These degenerations are regarded by Bayle, Laennec, and others, as the necessary precursors of cancer. This designation is exceedingly vague, as it is not deduced from the pathology of structure, function, or actions, but is entirely a figurative expression. Usually applied to ulcerations resisting all attempts at cicatrization, and extending themselves in every direction to the destruction of the surrounding tissues, *cancer* means no more than this species of termination, common to a great variety of lesions. Hence it is seen to be preceded by various states of the tissues, as a pimple in the skin, an excrescence, or thickening formed by a simple development of its tissues without new formation; enlargement of the capillary net-work or vascular tissue; morbid secretions and alterations of the cellular and lymphatic tissues—all these may terminate in cancerous ulceration without the presence of scirrus or carcinomatous matter.

The induration and the fibrous transformation of the tissues are often confounded with scirrus, but should be distinguished from it. This last consists in a hypertrophy of the cellular tissue, sometimes attended with its induration, accompanied with morbid productions or secretions of an inorganic matter of different kinds into its meshes or cellules. It does not, consequently, present invariably the same physical characters, and from these differences, although unessential, writers have formed different species of this affection.

This pathological production exhibits often a whitish, grayish, or slightly greenish colour, is divided and subdivided into lobuli of various sizes from being intersected by a dense cellular and almost fibrous tissue, and possesses a density which gives a gritty sound beneath the knife. It is then termed *scirrus—hard cancer.* The secreted product sometimes presents a granular aspect, from being deposited in separate cellulæ, and having thus a resemblance to the pancreas, the name of *pancreatic sarcoma* has been given to this variety of scirrus. Sometimes the morbid secretion manifests a gelatinous consistency and aspect, which gave origin to the term, by Laennec, of *colloid cancer.* These are no more than different forms of the same morbid condition, and are not to be received as so many distinct affections. Their essential character is a vitiation in the nutritive actions of the cellular tis-

sue, modifying its normal production, and attended with the deposition into its interstices or loculi of a morbid product or secretion.

Carcinoma, or medullary sarcoma, is analogous to scirrus in its nature and formation. The inorganic matter secreted in this instance, possesses a striking resemblance to the nervous medullary structure. It is opaque, white, or having a slight rose tinge, and is of a soft consistency, similar to the cerebriform structure. It has received, from this circumstance, the denomination of encephaloid and cerebriform matter, and has even been supposed to be a transformation into the nervous medullary substance. The conjecture is not correct. Tumours of this character are sometimes attended with considerable vascular development, and are deeply infiltrated with blood: in this state they receive the designation of fungus hæmatodes, which is also given to hypertrophy of the cellulo-vascular tissue, or accidental erectile tissue.

The exciting cause of the scirrous and carcinomatous degeneration of the tissues, is chronic irritation vitiating the mode of nutrition of the cellular tissue, and creating the morbid secretion into its meshes. This irritation is frequently independent of inflammation; it may be united with it; and always in the course of the disease excites inflammation in the surrounding tissue, which then complicates with its phenomena and attending consequences the primary affection. How far the fluids may be concerned in the production of these terrible alterations of the tissues, we want sufficient data to form any positive opinions—no adequate facts have yet been cited to show the part they take in these degenerations, yet the disposition to the recurrence of the affection after being extirpated, and to its propagation in different parts when once excited, appear to indicate some general cause as partaking actively in its formation.

The most common cause of the pathological alterations of the nutritive actions, and, consequently, anormal condition of the organic tissues, is unquestionably irritation. This is the result of the preceding examination; and it should of necessity be so, as nearly all the agents influencing the economy or modifying its actions, are irritants.

The opposite state—asthenia or abirritation does, however, prevail, and deeply affects the nutritive actions of the organs where

it occurs. In this state a less quantity of blood is contained in an organ, than in its natural condition, and various disturbances of function ensue. These will be treated of in pathology, when asthenia is the subject of consideration. The structure also experiences more or less of modification, but, with the exception of atrophy and softening, which appear in some instances to proceed from this cause, we are not in possession of exact facts in relation to this point.

Section III.—*Secretion.*

Secretion is the formation of various fluids or humours, from the blood, in different surfaces or organs of the animal economy. These fluids differ greatly from each other, in physical characters and chemical properties. A division has been made of them into secretions and excretions. The first containing fluids destined for some especial office or function, and often retained in the economy; the other, those fluids which are recrementitious, that are separated from the mass of the fluids for their depuration, and are rejected from the organism as incompatible with its healthy existence. As this division has reference to the fluids themselves, their nature, characters and objects, and not to the general facts, or modes of their production, which are the same for both, it will not be noticed in this place.

Secretion is analogous to nutrition; it belongs to the same order of phenomena, and is the result of precisely similar actions or movements. In *nutrition*, the solids are formed from the nutritive humour—the arterial blood—by the fixation of elementary molecules, specific for each structure, and by a special molecular or chemical action. In *secretion*, various fluids are formed from the same humour, with probably one exception, having each an especial character, determined by the organ secerning it, and consequently is the result of a specific molecular or chemical action in each organ. The *nutritive action* occurs in the intimate and ultimate structure, which is a participant of that action, and the result of which is a fixed organized solid. The *secretory action* takes place on surfaces which influence, but, most probably, do not enter into the action as one of its elements; it is an action of the fluid molecules, and the product is a fluid or humour escaping

from the surface where it is formed. Nutrition creates, renews, organizes the solid structure—secretion depurates and perfects the nutritive humour—the blood; adapting it to the purposes of nutrition and for the maintenance of vital phenomena.

The blood is the common source whence is derived the materials of nutrition and secretion. The great vascular parenchyma entering into the composition of the organs, places this fluid at the disposition of the different organs, and each by a species of affinity attracts from it the principles of its composition, or the elements of the fluids it secerns.

The apparatus of secretion is various, in some instances being very simple, as the cryptæ or follicles, and in others having a complex structure, as the liver and kidneys; it is always highly vascular. Particular organs are appropriated for specific secretions, required for especial functions. These are the glands, including some of the largest organs of the economy, as the liver, and the smallest, as the lachrymal gland. The proper glands are not, however, the sole secretory organs. The whole of the tegumentary system, especially the internal or mucous tissues, is a secretory surface. The alimentary mucous tissue through its whole track, the tracheal and bronchial mucous tissue, the genito-urinary mucous tissue, may, with propriety, be regarded as extended glands; the seats, in different portions of them, of varied secretions, which, under particular circumstances, are profusely poured forth. Every portion of the animal structure, even the bones, is capable of assuming the secretory action. Whenever an abrasion, a wound, or ulcer exists, secretion is a necessary occurrence; it is essential to the restorative or healing process. The glands themselves, as has been previously stated,* are regarded by many sound physiologists, as mere annexations to the mucous tissues, which, in every instance, penetrate into their interior with some modifications from the mucous surface, on which their excretory ducts terminate. The secretion of the gland is effected on the surface of the interior mucous tissue of the gland, as in the proper mucous tissues, and the excretory duct in its originating branches in the gland, is, in reality, the proper secreting tissue, the remainder of the glandular structure being a vascular reservoir, collating the fluid for the purposes of

* Part I. p. 71.

secretion, and, in the larger glands with compound secretions, preparing it by some modification, for their production. That the radical branches of the excretory ducts are the proper secerning portion of the glandular structure, is seen in the testicles and mammary glands.

Some of the secretions are formed chiefly from the red or coloured blood, as the urine and bile; others from the colourless portion of the blood, as the salivary and pancreatic fluids, and the semen. It is undetermined whether the bile be produced from venous or arterial blood. As the vena portarum, hepatic veins and hepatic artery, may be injected indiscriminately from each other, showing them to be fused ultimately in a common structure, it is most probable, the blood in the liver, is a mixture of both, and is a circumstance requisite for the formation of bile.

It is a received hypothesis, that nervous power is an active and essential agent in the performance of secretion. The correctness of this principle will be neither affirmed nor denied. It must, however, be regarded in no other light than a mere conjecture, and be received for no more. It must not be taken as a basis of established truth, on which may be erected a theory—no valid proof has been adduced to substantiate the doctrine. The crude experiments of Mr. Brodie for this purpose, and which have been unthinkingly, as we believe, admitted as competent evidence, cannot be acknowledged as such. That the secretions should be deranged and suspended, by the consequences of the mangling in vivisection, was to be expected. Accidents and wounds had long before proved the fact, and it is well known, that such a result attends on the inflammations of all the important organs, especially those of the abdomen; hence facts of a more single and conclusive character than Mr. Brodie's experiments, must be brought in support of this, at present, bare hypothesis, before it can be entitled to adoption.

Our own impression is rather in opposition to this conjecture. In the first portion of this work it was the opinion to which we were disposed to lean, but more mature reflexion and extended inquiry have produced a different impression.

Secretion and nutrition are taken to be mere modifications of the same action—phenomena of the same order. Now, nutrition is a process very active in an immense class of animals, in which

no nervous structure, or organs have been detected, and, in sound philosophy, it is not admissible to suppose a nervous power, which is a functional result, where nervous structure is not shown to exist. Besides, in vegetable beings, the organization of some of which, is infinitely more complex than that of numerous animals, and in which every attempt to detect a nervous structure has failed, for even the elaborate efforts of Dutrochet is another failure, secretion is a common function, possessed by all, and gives origin to an immense number of vegetable principles and products. It may be remarked, also, that secretion in vegetables, is effected by the common structure of the plant, independent of a specific glandular structure. It will be in vain to argue, that vegetables and animals being so different from each other, secretion may be a function in the one accomplished without nervous organs or influence, but which may be essential to it in the other. The differences between these two great classes of beings are restrained to the subordinate functions. The great phenomena of life are perfectly analogous in both—are sustained by the same agents—their vital forces are of the same nature, and all the essential phenomena are materially the same. From the essentialities of the important vital functions of the one, we may safely infer as to the essentialities of the other. The principal fact relied on in support of the nervous hypothesis, is the influence exercised by certain passions and emotions, over some of the secretions. But this fact proves nothing more, than that the brain is embraced in the chain of connexions, combining the various organs of the higher animals, forming a unit to a certain extent, of the economy, and by which one organ exerts an active, and often perturbating influence on other organs. It does not establish a positive essential nervous influence, as indispensable to the secretion itself.

From these considerations we are inclined to doubt most strongly, the correctness of the nervous hypothesis of secretion.

The secretions are highly vital phenomena. They belong to all organized beings, animals and vegetables. The conservation, the existence of the individual, and the perpetuation of the species, are immediately dependant on fluids, the products of secretion.

The secreted fluids or humours perform various offices, are the agents of different functions in the economy. They may be divided into two classes; the first embracing those connected with

the conservation of the individual, attached to the acts of nutrition, or the exercise of the senses; the second, comprising the fluids destined to the perpetuation of the species, and united to the generative actions.

The first are persistent, and continue during the existence of the individual; the second are limited to certain periods of life, and, in some animals, to particular seasons, or occur only under certain conditions.

The fluids of these classes are again separable into other divisions. Those of the first may be divided into,

1. The fluids necessary to the healthy constitution of an organ or tissue, and the exercise of its functions;—such is the mucus of the various mucous tissues. It lubricates their surface, keeps them moist, renders them impressible, and preserves their absorbing and exhaling faculties. Such also, are the sebaceous humours of the skin, cerumen of the ears, the tears which keep the eye moist and cornea transparent, the fluid of the joints and capsules, the serosity of the serous tissues, &c.

2. The fluids effecting the digestion and assimilation of the aliment. These are the saliva, gastric liquids, the pancreatic liquor, and the bile.

3. The fluids that are purely depurative eliminating from the economy matters foreign to its composition, aggressive to its structure, and disordering its actions, that may have been introduced through various channels; or the elements of the structure, disengaged in the formative act of nutrition, and unfitted for the purposes of organization.—These are the urine, and the sweat.

The fluids of the second class form two divisions. 1. The prolific fluids, the immediate agents of generation;—such are the fluids of the ovaries and the germ they contain; the semen, the prostatic liquor, and that of the vesiculæ seminales, glands of Cowper, &c.

2. The fluids that nourish the young in the first periods of life—as the milk.

It is a question yet undetermined, whether the secretions exist in the blood, and are merely separated from it by the secerning organs, or whether they are generated by a specific action in the organs. The truth, probably, lies with both opinions, and either, exclusively, is incorrect. The analysis of the blood and of the

different secretions, has not yet been accomplished in that perfect and minute manner, which is required for a full and fair investigation of the subject. Some of the principles of the secretions undoubtedly do exist ready formed in the blood. Prevost and Dumas have asserted, that when the kidneys had been extirpated in animals, they were enabled to detect urea in the blood. This experiment, however, wants confirmation. Begin repeated it without success, and M. Serrullas was equally unsuccessful;—he could not detect a trace of urea in the blood. Foreign substances introduced with the food, or otherwise, through the stomach or other entrances into the economy, are eliminated by the different emunctories. They are merely separated from the circulating mass.

There can be little doubt that most of the secreted fluids are not formed by a process of this nature, but are the product of an action existing in the organs. The fluids of the second class, that appear only at certain epochs, or under particular and temporary circumstances, cannot be supposed to exist previously in the blood. They result from an excitement awakened in the organs, and are augmented suddenly by the stimulations affecting directly those organs. This fact is general to all the secretions, and they are seen to increase or diminish with the degree of excitement and activity of the circulatory movements of the secreting organs. This rapid augmentation of the secretions, under the influence of irritating impressions, is entirely hostile to the supposition of their existence in the circulating humour, from which they are simply disengaged in the glands. This augmentation will continue for months, as in the cases of chronic bronchitis, and chronic dysentery; and it cannot for a moment be contended, that the excessive secretion and discharge of mucus in these instances, depends on any other cause, than the irritation of the tissue whence it proceeds;—it cannot be supposed to be connected, in the slightest manner, with an unusual or morbid excess of mucus in the blood. To the same purport may be adduced the facts of the morbid alterations of the secretions, and the numerous pathological secretions attending on especial diseases. Every irritation of a secerning organ or surface, is attended with a vitiation of the secreted fluid, commensurate with the degree of irritation; and the different eruptive diseases have secretions of a peculiar cha-

racter formed in the skin. Ulcers, which are secreting surfaces, will present an immediate alteration in their secretion, if they be irritated, and an inflammation be excited in them.

The above facts are irreconcileable with the doctrine of the pre-existence of the secreted humours in the circulating fluid, and are evidences that they are the product of the action of the secreting organs—formed in them, from the elements contained in the blood, and, consequently, by an action which is formative, molecular, and of a chemical nature.

Secretion, like nutrition depends on excitement, and is sustained by the normal or common excitants maintaining the physiological actions of all the organism. It is always an effect, and is an evidence of activity in the movements of the secretory organs. Increase of secretion can never be consequential to loss of activity, to a passive state, or the asthenia of an organ; it then diminishes in quantity. In those circumstances transudation is sometimes mistaken for secretion.

Exhalation or *transpiration* is a phenomenon somewhat analogous to secretion. It is of a simpler character. All the surfaces of the body, internal as well as external, are the seat of an exhalation more or less active. This exhalation consists almost entirely of watery vapour, slightly impregnated with some animal matter. The skin and bronchial mucous membrane, manifest more especially this phenomenon. It is constant, though in the usual temperature it is not obvious, being insensible; hence termed insensible transpiration. The pulmonary exhalation in a low temperature, and moist atmosphere, is often visible, from its condensation as a vapour issuing from the mouth. This seldom occurs with the cutaneous transpiration, which condenses on the surfaces when it is not dissolved by the atmosphere, and trickles down the skin in the form of sweat.

The quantity of the exhaled fluids is very considerable. Numerous experiments, from the time of Sanctorius, who devoted nearly his whole lifetime to the investigation, down to the present period, have been made to determine the exact amount. They present no constant character in this respect; but vary greatly from circumstances. According to the experiments of Lavosier and Seguin, the insensible transpiration amounts, in the circumstances the most favourable to its promotion, to thirty-

two grains a minute, or five pounds in twenty-four hours.* The least quantity is eleven grains a minute, or one pound eleven ounces in twenty-four hours. The medium amount was ascertained to be about eighteen grains a minute, of which eleven consisted of cutaneous, and seven of pulmonary transpiration.

In the digestive mucous membranes transpiration is much less active than in the skin and bronchial mucous tissue. In the suppression of the discharge from these last, it often augments greatly, causing the diarrhœa with copious watery stools, succeeding suddenly from continued exposure to a cold and damp atmosphere. It is also excited by certain purgatives, especially saline purgatives.

In the surfaces opposite currents are in this manner established, introducing a variety of exterior matters into the interior of the economy, and ejecting others without it. The absorbing current or endosmose, is most active in the alimentary surface—the exhalent current or exosmose has the ascendency in the skin and respiratory surface.

By the antagonism of these functions is maintained the balance in the nutritive actions of the economy, the body returning, notwithstanding the constant additions it receives in each twenty-four hours, nearly to the weight of the preceding day.

The serous and cellular tissues exhale a serosity which preserves those tissues soft, smooth, pliable and adapted to the motions of the organs.

Foreign substances introduced into the economy may frequently be detected in the exhalations. Many odours are to be perceived in the pulmonary exhalation, in the cavities of the serous tissues when opened, and chemical agents reveal the presence of certain saline substances in the effused serum.

Transudation differs from exhalation.—It is less of a vital, and more of a physical result. All the tissues of the economy, as all natural agents, possess porosity, and are penetrated, in different degrees, by various fluids, and even solids. In absorption, these substances permeate the tissues urged by forces not yet demonstrated, but which are imitated in the transmission of fluid and solid matters by galvanic currents. Exhalation and secretion are

* French weight.

results of analogous powers, but transudation partakes of the mechanical oozing of the more fluid portions through the pores of containing tissues. The cold sweats with pallid and algid skin of the fainting, the dying, and the succumbing in the cold stages of malignant diseases, are of this character. The hydropic effusions from obstructions to the course of the circulation, arise also from this cause, and are unattended with any appearances of morbid change in the effusing tissues. Transudation is always attended with signs of a passive or asthenic condition, a want of activity, and a softened relaxed state of the tissues. In these respects it differs entirely from secretion and exhalation, which are always active phenomena.

Pathological states—The secretions and exhalations being derived from the blood by actions belonging to the glandular organs, to the secreting and exhaling surfaces, follow necessarily the deviations of those organs and surfaces from a natural condition, and must be affected by varying states of the sanguine humour. In this, as in so many other particulars, secretion bears the most striking analogy to nutrition. The immediate cause of the greater portion of the pathological affections of nutrition, as connected with the organs, it has been seen, is the complex phenomenon of irritation, disturbing the order of the molecular circulation or actions of the tissues. The same cause, as excited by the direct aggression of offending agents, foreign to the economy, by over-stimulation of the natural excitants, or by sympathetic transmissions of a pathological irritation from other organs, is to be attributed most of the disordered states of the secretions.

The aberrations of the secretions from a natural condition may be placed under four heads. 1. Simple increase of the secretion. 2. Vitiation, perversion, or alteration of its qualities. 3. Diminution or entire suppression. 4. Its displacement, its *error loci*, or appearance in a part where it does not belong.

1. Increase of secretion unattended with change of qualities, or but slightly altered in properties, results from a simple increase of excitement of the secreting organ. Thus, the chewing of pellitory root, by irritating the buccal mucous membrane, causes a copious flow of saliva—any slight inflammation of the same tissue produces the same result. In light catarrhs, is observed, an augmented secretion of the mucus, with increase of

the aqueous exhalation of the nasal and tracheal mucous membrane, and that of the fauces; the same occurs in light forms of bronchitis, when the expectoration is copious, and consists of mucus dissolved in a thin serous fluid; the same is presented in some diarrhœas, arising from the action of cold on the external surface; the bilious vomitings and diarrhœas common in warm seasons, appear to arise from merely an excessive secretion of the biliary apparatus.

2. Vitiation or alteration of the qualities of the secreted fluid, is produced, whenever the irritation of the secreting organs acquires a certain intensity, or passes into inflammation. The molecular circulation of the organ is denaturalized, and the combinations of the component elements of the secretions no longer take place in their natural order, whence are formed new products, as is seen in nutrition under the same circumstances. Numerous instances illustrate the proposition. The saliva, when the buccal mucous tissue is inflamed by the action of mercury exhibited to salivation, differs in its qualities and characters from the natural secretion. It is charged with albumen, becomes viscous, is sometimes sanguinolent, has an offensive odour; and these, with other unnatural characters acquire a development in correspondence with the degree of inflammation existing.

The mucus of the nares, the fauces, the trachea and bronchi, manifests also numerous morbid deviations in the inflammations of the mucous tissue which clothes them. It is often puruloid, it exhibits various coloration—there are striking differences in odour and taste, it acquires a greater consistency, containing fibrin, becoming tenacious, firm, and is expectorated with great difficulty. In one instance of chronic bronchitis, I saw it gelatinous, resembling boiled tendon.

The biliary secretion experiences, doubtless, a variety of alterations, but which are not accurately determined. In the gall-bladder we find fluids of very dissimilar properties. It exhibits various shades of yellow from a light to a brown, is deep black-green, and is sometimes a colourless mucus. Vitiated bile was formerly a conspicuous feature in the pathology of disease, and with many, even at the present day, is regarded as deeply implicated in the production of disease. Yet it must be confessed that we have no certain, no positive facts that can substantiate the doctrine, which rests solely on conjecture.

The urine presents diversified departures from its natural properties and characters. So intimately are these associated with the pathological states of the organs, that this secretion has been more relied on, and with greater propriety than any other, for sure indications in establishing a diagnosis or prognosis in diseases. In acute or chronic affections it should always be attentively examined by a judicious practitioner. The specific changes of this secretion are too numerous to be pointed out, in detail, in this place. It will be sufficient, to remark, that the kidneys possess an acidifying process, by which the simple elements, the basis of acids, existing in the blood, appear as acids in the urine. This process becomes more active in all acute inflammatory diseases; the urine then is scant, its acid and saline elements more abundant, and acids which do not appear in it in the healthy state, are formed.

The serous exhalation has numerous anomalies proceeding from the inflammation of the serous tissues. It is sanguinolent, turbid, gelatinous, loaded with plastic lymph, and possesses other deviations. The cutaneous exhalation is not less irregular.

The preceding instances are sufficient to establish the fact, that inflammatory irritation uniformly and of necessity, occasions a vitiation of the secreted fluids, or an entire alteration of their qualities.

The vitiation of the secretions of the alimentary and digestive organs, is assumed, by some modern pathologists, as one of the most important elements in the class of diseases termed, by them, idiopathic fevers, and as justificatory of the lavish employment, in those affections, of active purgatives. This treatment is objected to by the advocates of the physiological doctrine of fever, who regard the idiopathic fevers of the nosologists as inflammatory irritations of some portion of the mucous tissue of the alimentary canal—that is, gastro-enterites—and purgative medicines as irritants acting on a surface already the seat of an irritation destructive of its functions, and threatening to its organization.

That the secretions are so depraved as to acquire highly noxious properties, is most certainly a conjecture merely—it has not been established by a demonstrative proof, and must not, therefore, be admitted as a truth, on which to build a theory, or be received as the sanction of an unquestionable practice. But admit the fact,

and what is the inference? The secretions being the product of organs, the organs must have preceded the secretions in the departure from the natural state—and the most important consideration in the treatment, is the restoration of the organs to a healthy state—when the secretions will, as a matter of course, become healthy. But further, if the denaturalized secretions are capable, by their irritation of the alimentary mucous surfaces, to increase and perpetuate the morbid affection, how can drastic cathartics, the most intense irritants of the same surfaces, exercise a salutary operation? will they not be attended with the same injurious operation as these supposed irritating secretions?

That the altered secretions are so highly irritating, and exercise so deleterious an impression, as is assumed by those writers for the purpose of sustaining a favourite system, cannot be received without substantive evidence. We regard the assertion, in its full extent, as most questionable. It is not countenanced by what is observed of the secretions of other surfaces. No one accuses the vitiated secretions of acute and chronic bronchitis, or pneumonia, of a participation in the production of the morbid condition attending these diseases. The great derangements of the urinary secretion, so frequent in occurrence, exert a very slight influence on the bladder and urethra, except in the case of sabulous or calculous deposits, which act only mechanically. But, if morbid secretions produce effects in the surfaces on which they are deposited of so perturbating a character, they ought to be more frequently manifested in the bladder and urethra, when the urinary secretion is profoundly altered.

The circumstance most adverse to the supposition, is deduced from the phenomena of intermittent fevers. The febrile paroxysm is often most intense; the secretions are profoundly affected; yet, when the paroxysm terminates, no disorder or disturbance in the digestive organs, or alimentary canal, or other organs, reveal the potent energy of these pernicious secretions, to which so much mischief is attributed in fevers.

In addition to the above facts, which are special, the general fact, or organic law, may be cited in direct conflict with the position assumed. Between an organ or surface, and its product, a relation always exists which places them in harmony. The product of an organ, formed by its action, and after the mode of its

vitality or being, cannot be possessed of properties very inimical to that organ, and affect it in an aggressive manner. The secretion of an irritated organ, though denaturalized, has merely followed the aberrations of the organ, and is natural to the organ in its then state, and we ought to expect, will no more react on it than the healthy secretions do on the organs which produce them.

Without denying absolutely that the secretions, when they have widely changed from their normal composition, may possess some irritant qualities modifying the organic actions, yet we must, before admitting the proposition to the extent claimed for it, demand the evidences, that vitiated secretions in the alimentary canal are largely concerned in the pathology of fevers. We are more inclined to regard it as a mere conjecture, to which those, who have been driven from the grounds they formerly assumed, have now resorted to in the defence of a system they have found untenable, but which they cannot reconcile themselves to abandon. We too often endeavour to find excuses and justification for our errors, rather than to acknowledge we have been deceived, or forsake practices pursued for years without detecting their impropriety.

3. *Diminution and Suppression.*—Irritation of an organ passing into acute inflammation, or terminating in congestion, occasions a sensible diminution in its secretion, or entirely suspends it. When inflammation assumes an intense character, the circulatory movements are embarrassed, accumulation of red blood to an undue extent prevails, the quantity and quality of the organic fluid of the affected organ are no longer in their natural order, and hence proceed the vitiations heretofore indicated in nutrition and secretion. This last often is arrested entirely. Numberless instances could be adduced in proof of the fact. A few may suffice. In catarrhs and bronchitis assuming a severe character, the secretion of the nasal and bronchial mucous membrane, at first copious, diminishes with the advance of the disease, and finally ceases. The Schneiderian membrane is red, dry, and painful; the cough is hard, without expectoration, with sense of stricture in the chest, and embarrassed breathing.

The mucous membrane of the mouth, when acutely inflamed, whether from mercury or other causes, is unproductive of salivation. It is turgid, painful, ulcerates, pours forth a sanious or

bloody fluid, is covered over with exudations, and sometimes sloughs.

Gastritis, when intense, is attended with frequent efforts to vomit, productive of great suffering, nausea is constant, the stomach rejects every thing presented to it, even liquids, except in small quantities, and very cold.

The bowels in enteritis are constipated, from the suppression of the secretion and exhalation of their mucous tissue; the attempts so frequently made to open them by irritating cathartics, aggravate the evil, maintain the inflammation above the point of secretion, and urge the structural disorder on to disorganization.

In nephritis, the secretion of urine is suppressed, and in acute urethritis, the secretion of the urethral membrane is dried up, the canal is impervious, from the turgescency of the lining tissue, and the urine cannot be excreted—it is a cause of retention.

Congestion of the tissues equally destroys, with inflammation, the secretions of which they are the seats. This state ensues frequently from slight irritation, before inflammation is developed. It invades suddenly, and disappears rapidly. All the vascular organs and tissues are subject to the occurrence of congestion—and its uniform consequence is suspension of their functions—and the secreting surfaces are dry.

4. *Displacement or occurrence of a secretion from an organ or surface where it does not belong.*—This circumstance is rare, but has been observed in some extraordinary cases. The urine is the secretion which has chiefly presented this anomaly. It is the paruria erratica of Good. The urine has been seen to be discharged from the salivary glands, the skin, nipples, ear, &c. A most remarkable case of this kind was published by Dr. S. Arnold, in the American Journal of the Medical Sciences, Vol. I.

Section IV.—*Animal Temperature.*

Animals possess the faculty of generating heat, and of maintaining their proper temperature, unaffected, except in great extremes, by the temperature of the mediums surrounding them. The term animal heat, or animal temperature, designates the caloric evolved in this manner. The degree of animal temperature varies very considerably in the different classes, orders, and

species of animals. It is not always uniform in the same animal, but suffers changes from circumstances that modify the phenomena of its life or vital activity.

The mediums in which animals live, are almost constantly of less temperature than the animals themselves; and hence they are incessantly losing their caloric. The production of heat is, consequently, unintermitting in the animal organism—is connected with those movements or actions, that are essentially vital. The two are intimately associated: they invariably run together. The animals that exhibit the highest manifestations of vital activity, in whom the actions of life are the most numerous and rapid, possess the most elevated temperature, generate heat with the greatest rapidity, and resist most firmly the changes of external temperature—such are the two first classes, mammalia and birds. But even those animals which, from their lower temperature, are called, not very correctly, by naturalists, cold-blooded animals, such as reptiles, fishes, the crustaciæ, insects, molusca, and worms, possess also their proper temperature, though it varies with greater facility from the fluctuations of the temperature of the external medium.

The power of producing heat and maintaining the temperature, varies considerably amongst the mammalia. With some it is much feebler than with others. The marmot, the bat, and some others, are so much affected by the external temperature, that all their faculties of life, the manifestation of vital activity are suspended, when it approaches the point of congelation, and at a few degrees below zero they are frozen. Others, on the contrary, as the reindeer, the white polar bear, the polar fox, resist even 20, 30, and 40° below zero.

A temperature considerably above animal heat, augments but slightly the heat of the body. At most it does not acquire more than four or six degrees. Experimenters have exposed themselves to as high a temperature as 250° F. without experiencing injury. A faculty or means is consequently possessed by animals, which enables them to maintain their proper temperature, when exposed in mediums of excessive heat. This faculty is connected with the evaporation of the aqueous portion of the fluids constantly exhaled from the surface of the lungs, and the exterior of the body.

The increased evaporation of the fluids neutralizes the excess of caloric, or carries it off in a latent state, and thus prevents the augmentation of the temperature of the body. A very elevated temperature could not be borne with impunity for a considerable period, as the means of preserving the proper heat of the body would, before long, be exhausted, and the disorganizing influence of caloric could not be resisted.

The production of heat in the animal organism, has attracted a large share of attention amongst physiologists, and numerous hypotheses have, at various times, been proposed to explain this phenomenon. They have all, more or less, been founded on the prevalent doctrine of the day, with respect to heat—and, from the very nature of the subject, the indissoluble connexion between them, the cause of animal temperature can be elucidated satisfactorily, only when the theory of caloric is thoroughly developed. The facts of animal temperature belong almost entirely to the category of the facts of caloric; they are attached to the facts of vitality rather incidentally, and as consequences, than in chief.

Before proceeding to the investigation of the cause of animal temperature, it will be necessary to premise the general facts of caloric, as they are known at the present period; for it is on these facts that must repose a consistent doctrine for the explanation of this phenomenon.

1. Heat and combustion, phenomena so well understood, it is not necessary they should be defined, are ascribed to the agency of a cause which is named caloric. The nature of this agent is wholly unknown, and all that we do know, and probably are capable of knowing respecting it, are the effects or phenomena it originates.

It is usually assumed as an hypothesis, that caloric is a material fluid; but of a tenuity so inappreciable, as to escape every means of detection by our proper senses. Its particles are supposed to be endowed with indefinite idio-repulsive powers, and distributed amongst the particles of ponderable matter, modify cohesive attraction, producing the various forms of gaseous liquid and solid, that matter possesses.

This hypothesis very happily explains a number of the phenomena depending on caloric, but there are some facts which it does not meet, and which cannot be solved by its application to them.

The heat produced by friction, by percussion, and by some chemical changes, are of this character.

It is therefore to be understood, that in adopting this idea of caloric, it is to be viewed in no other light, than as a mere hypothesis—that it is not a demonstrated theory, and we must not suffer it to influence too far our reasonings on the phenomena of caloric.

Another hypothesis that has been proposed in explanation of caloric, denies entirely its materiality, and accounts for its phenomena on the supposition of a vibratory or undulating motion in the particles of bodies. The principal advocate of this doctrine was Sir Humphrey Davy, whose deservedly celebrated name stamps a value on the opinions he adopted.

2. Caloric in a state of activity, or free caloric, gives origin to a variety of phenomena, as the sensation of heat, combustion, expansion, the conversion of solids into liquids, and fluids into gases, and, in organic bodies, excites and maintains those movements or actions of which life consists.

3. Whenever caloric is put into action, or manifests phenomena, there is always movement or change in the particles or atoms of bodies. All the movements of the molecules of bodies, causing change of state, are attended with change of temperature, and combustion is no more than a result of this movement, that is, "an adventitious accidental accessory to chemical combination or decomposition, or the internal motions of the particles of bodies, tending to arrange them in a new chemical constitution."

4. Heat or caloric in activity is distributed amongst surrounding bodies until they acquire the same temperature. This distribution results from the radiation of heat, from its conduction or its transmission through solids, and from the circulation it establishes in fluids.

5. Bodies differ as to their power of conducting heat. Fluids possess it only in a very low degree. All soft, porous bodies, whose interstices are filled with air or fluids, are bad conductors, and animal bodies while living being imbued with liquids belong to the class of imperfect conductors.

6. The capacity of bodies for heat differs, but as MM. Petit and Dulong remark, "the attempts hitherto made to discover some laws in the specific heats of bodies have been entirely un-

successful." The inaccuracy of the measurement is so great that very little reliance is to be placed on the usual statements of the specific heats of bodies. Those only which may be regarded as exceptions, and which can be received with confidence, are the few observations of Lavoisier and Laplace, and those of MM. Delaroche and Berard, and MM. Clement and Desormes for the elastic fluids.

Having premised the preceding general facts in relation to our knowledge of caloric, we are prepared to examine the production of heat in animals.

The doctrine of animal temperature the most accredited, if not exclusively adopted at present by physiologists, is that of Crawford, or some modification of it. According to this theory, animal heat is generated in the lungs by the process of respiration, and from this source is diffused by the circulation throughout the animal economy. The cause immediately productive of heat, in the process of respiration, is asserted to be the combination of the oxygen of the air with the carbon of the blood, and consequent formation of carbonic acid gas. Now, it is stated by Crawford that the specific heat of oxygen is very considerably greater than that of carbonic acid, and, of course, when oxygen combines with carbon, an extrication of heat must necessarily ensue. The amount of heat, to correspond with Crawford's ratio of specific heats of oxygen and carbon, that would thus be disengaged in the lungs, if not neutralized and rendered latent, would have been sufficient to have produced a red heat in iron. By the experiments of Crawford, the specific heat of air being sixty, that of oxygen was 2.65, while carbonic acid gas was 0.586. The whole theory of Crawford, it is apparent, rests entirely on this fact, and if he has committed an error in this respect, the fabric he has built on it must fall. Now, the later, and far more accurate experiments of MM. Delaroche and Berard, and of Clement and Desormes, performed independent of each other, with ingenious and well-contrived apparatus and different processes, have shown the calculations and results of Crawford to be entirely erroneous. It is to be remarked that these experiments were not undertaken with any reference to the statements of Crawford, or in connexion with any physiological views, but simply to ascertain the specific heats of the different gases by experiments of

the most conclusive character. From the extensive observations of these philosophers, it results, that the specific heat of carbonic acid is, according to Clement and Desormes, from which Berard and Delaroche differ only by some fractions, 0.987, and that of oxygen, 0.9000, that is, the specific heat of carbonic acid instead of being, as Crawford makes it, four times less than that of oxygen, is a fraction greater. On the principles of Crawford's theory, in the process of respiration there can be no material change of temperature, and instead of a development of heat, it is rather a diminution of temperature that would occur.

The doctrine of Crawford thus destroyed in its fundamental proposition, falls into ruin; and in its overthrow, carries with it all the modifications of which it served as the basis.

The invalidity of the theory of Crawford, which is no longer applicable to a solution of the phenomena it attempts to explain, forces us to look for some other source for the production of animal heat.

Mr. Brodie a few years past, from having observed that those animals killed by poison, or which had the spinal cord destroyed for the purpose of depriving the animal of all sensorial influence, cooled more rapidly than others in which the nervous system was uninjured, arrived at the conclusion, that the temperature of warm-blooded animals is considerably under the influence of the nervous system.

The experiments of Mr. Brodie, by no means very conclusive, have been repeated and varied by Dr. Holland, who details the particulars in his work on the "Laws of Organic Life," and have proved, when brought to the test, to be incorrect and defective. No facts have, therefore, as yet, been adduced to show that the nervous system exercises any other influence on animal temperature, than that of other organs important to the whole economy, and whose lesions affect more or less the organic actions of the general organism.

The insufficiency of the doctrines heretofore proposed, for the explanation of animal heat, is too obvious to admit of contradiction, and it will be necessary to indicate another source whence it may proceed.

In the propositions on caloric, it was there stated as an axiom, that all movements of the molecules of bodies, or a change in

their state, are attended with change of temperature. This law is universal. Now, the actions of organized beings, which are termed vital actions, or organic actions, are always formative, consist essentially in changes in the state of the molecules composing the tissues, or are a molecular composition and a decomposition. This action, which is common to every organized being, must come under the general law of caloric, that every movement of the molecules of a body, or a change of their state, is attended with change of temperature.

Animal heat in this view, is an effect, an attendant on the organic actions; is produced as a consequence of the molecular actions and reactions incessantly taking place, while vitality continues, and which are in reality the vital actions.

If the view taken be correct, animal temperature will always accord with the activity of the organic actions in any individual, and it will consequently be a standard or measure of the force of those actions in that individual, compared with itself at different times, or with other individuals of the species. Organized bodies differing very materially from each other, not only in their organization, but in the elements of which they are constituted, and the specific caloric of all bodies having relation to the weight and nature of their atoms, the organic or vital actions of animals differently constituted, ought to produce, on the theory proposed, a temperature specific for each species, and this is proved by observation to be really the fact.

Upon the same principles, the specific heat of animals, whose organism is the most complex, whose organic actions are the most intense, whose changes are the most rapid, and the atoms of whose elements possess the highest specific *gravity* should manifest the highest temperature. Now, all these conditions belong to the class of animals that are called warm-blooded, in which fibrin and the red globules of blood prevail more than in any other animals.

From the same principles it should follow, that animal heat should be highest in those portions of the body where the organic actions are most active; and should augment with the increment of the organic actions. Now the lungs, the seat of the molecular actions constituting respiration, the liver, pancreas, kidneys, the stomach, the intestines, &c.; the seats of the active molecular changes of secretion, digestion, chylification, fecation, &c. should

necessarily develope change of temperature in the highest degree; and it is in the chest on the diaphragm, and the upper portion of the abdomen under the diaphragm, that the thermometer manifests the highest degree of animal heat. It is lowest in the extremities, where the molecular movements of composition and decomposition, or change of state, are the feeblest.

Pathological states.—The animal temperature varies from pathological conditions of the organism. This must be a necessary result, from its dependance on the organic actions. If disengaged in the changes effected by those actions, as has been just inferred, it must follow them in all their changes; and observation shows a perfect accordance between the degree of animal temperature and the activity of the organic actions.

The animal temperature presents three variations from the normal standard. It rises above, sinks below it, or is unequally distributed.

The first is manifested in all acute inflammations: when they are external we have the evidence of a corresponding augmentation of temperature in the inflamed part. It is seen in whitlow or felon—in furunculus—in anthrax—in erysipelas. A very local or limited inflammation does not affect the temperature generally—the alteration is confined to the part affected.

The phlegmasiæ, in their state of acuity, are productive of increased temperature, which is diffused, when they excite fever.

Increase of animal temperature is the most prominent character of fever. It is this, which in all languages has led to the adoption of the name designating that phenomenon. If the theory of animal heat that has been proposed should be adopted as correct, it will tend to determine the nature of fever, a question so long vexed in medicine. This state would then be regarded as the result of an over-excited state of the organic actions, and places fever in a dependancy on a state of inflammatory irritation; or makes it, in other words, a mere symptom of that condition. Acute inflammations are productive of increased temperature in the part inflamed; the recognised phlegmasiæ, or internal inflammations, when acute, excite fever; and the direct, logical deduction, therefore, is, that fever, in all cases, unless the contrary be absolutely shown, is a result, or symptom, of inflammatory ir-

ritation, though its seat may not be as decidedly recognisable as in the well-established phlegmasiæ.

To the production of febrile heat several circumstances concur. The internal inflammatory irritation gives necessarily evolution to heat, of which a consciousness exists in the sensations of the individual, and the instinctive demand for cold drinks. But the material of the body being a bad conductor of heat, it cannot be diffused by a mere conducting process throughout the economy. Now, the blood which circulates in large quantity in the internal irritated organs, must acquire the temperature of those organs, elevating it two, three, or more degrees above its normal standard. This blood passing into the circulation is diffused throughout the economy with its increased temperature, which it communicates to the organs which it permeates and traverses. The general temperature is thus augmented, whilst heat continues to be evolved in the interior, and the centrifugal movement of the blood is not arrested.

The blood, besides, from its augmented temperature, is rendered more stimulant, more excitant to the organs, and, as it penetrates them, quickens the organic actions, and in this manner more caloric is evolved than in a natural state.

Another cause augmenting the animal temperature in fever, is the suspension of the secretions, and especially the cutaneous transpiration, which neutralizes or carries off a considerable portion of the heat generated in the economy.

The heat of fever may then be attributed to three causes—1st, an internal inflammatory irritation evolving an excess of caloric, which is conveyed and diffused by the circulating fluid throughout the organism; 2d, to a general augmentation of the organic actions arising from the more stimulant energy possessed by the sanguine fluid; 3d, from the suppression of the secretions and transpiration of the external and internal surfaces, which no longer neutralize the caloric evolved, or render it latent.

Diminution of the animal temperature below the normal standard, is an occurrence nearly as familiar as its augmentation. It is the character of the state precursory to *fever*—the cold stage or period of chill—preceding the reaction of which fever essentially exists; it is the distinguishing feature of the *algid inter-*

mittent, or cold plague of the southern states; it is a predominant symptom of spasmodic cholera; it attends on acute attacks of nephritic pains; of spasmodic colic; spasms of the stomach; and in all cases of extreme internal congestions.

To all of these affections, so different from each other, a common circumstance belongs. The movement of the sanguine fluid is centripetal; it concentres towards an internal organ labouring under excitement, in which the vital energies of the organism are concentrated, and whose organic actions are exuberantly developed. As a consequence of this state of things, the external surface is exhausted of its sanguine fluid, its vital energies are prostrated, and its organic actions, or movements of life, enfeebled to the lowest grade. Hence its algidness, its palor, its defective sensibility and excitability; while at the same time, in the suffering internal surfaces and organs, there exists a sense of burning heat; they are the seat of acute sensibility, and manifest often an excessive irritability.

The animal heat falls below the natural temperature under circumstances different from the preceding. A universal coldness pervades the frame, internally as well as externally; the breath returns chilled from the lungs; exhaustion prevails in all the organs; the powers of life are ebbing to a close; and the organic or molecular actions generative of heat are reduced almost to extinction. It is the state the precursor to dissolution in many cases of malignant or ataxic fevers of various forms, or proceeding from the action of animal and other deadly poisons, destroying the vitality of the blood, and existing in other cases attended with sudden general exhaustion of the vital energies.

In the first class of cases, the skin, in the greater number, is either dry or merely moist; while in the last it is generally bathed with a profuse and clammy moisture, apparently the leakage of the aqueous portion of the blood through the porous structure of the surface, separating from the other constituents of that fluid in the extinction of its vital affinities.

The *unequal distribution* of the animal temperature is a frequent occurrence in disease. In acute cerebral affections the head is hot, and the extremities are cold. When acute inflammation of the abdominal viscera are present, when patients labour under some of the forms of gastro-enterites, the abdomen possesses an

elevation of temperature superior to that of any other portion. I have observed the same fact as to the thorax in affections of the lungs. Ataxic fevers, which are so frequently complicated gastro-enterites, exhibit the same disproportion in the temperature, the head or abdomen being the parts of excessive heat.

In all these facts, it is to be observed, 1st, that the development of heat corresponds exactly with the degree or extent of the organic or nutritive actions, or the molecular movements of composition and decomposition, existing between the solid and fluid elements of the organism, which are vital actions; and 2d, that excess of temperature beyond the normal degree is found in the immediate vicinity of the organ or tissue the seat of the inordinate and exalted movements of the organic actions; and 3d, from these is derived the conclusion, that the animal temperature is a measure of the activity of the organic actions, and an indication of the treatment to be pursued.

CHAPTER VI.

Connexions of the Organs.

The animal organism is a mechanism of exceedingly complex structure and arrangement; it displays a vast diversity of phenomena; and executes numerous and dissimilar functions. The preceding investigation announces this result. Primary elements, having each its specific properties, are the basis of its structure; assuming definite forms, they present peculiar arrangements; the tissues constructed of them possess each its separate and distinct characters and nature; and the organs composed of these, perform each a specific office, have each its own mode of being, are called into, and maintained in action, each by its peculiar and appropriate excitants, and are influenced each to a certain extent by specific modifiers.

The organs, by this independence, approach in some degree to the character of distinct animals. The animals of simplest form

manifest a perfect independence of one portion to another; each part containing in itself all the requisites of its vitality, and being capable of becoming a separate being. Plants also manifest to a great extent an exemption from a dependancy of one part on another—and when these parts are separated, they are capable of continuing their existence as distinct individuals. Plants are in reality an aggregation of individuals, merely united to a common trunk, but not depending for existence on each other.

Notwithstanding the great diversity in the structure, vital force, and functions of the organs, yet they are not, in the animals elevated in the scale of organization, wholly independent. They are most intimately associated—one organ and its function are made subservient to another organ and its function—a *consensus* prevails throughout the organism, bestowing on so many and various parts a harmony of co-operation to a single end, and a unity of individual existence. The more elevated is the rank of the being in the animal scale, the more complex is its organization, the more entirely does this mutuality of dependance prevail. No one organ can experience any important modification in its mode of being, or its faculties, without influencing or involving in its own aberrations the condition and faculties of other organs, and the death or disorganization of one organ must of necessity entail the death of all.

This close association allying the organs in a common bond of union, this general *consensus* pervading the animal economy, by which the modifying impressions, actions, and condition of one organ, whether physiological or pathological, are transmitted and rendered common to other organs, implies some means by which this connexion and transmission are established and maintained. What these are, in what consists this connexion of the organs, are the subjects that now place themselves before us for investigation.

In taking a survey of the organs and functions of the economy, the relations and connexions existing between them, their modes of influencing each other, may clearly be referred to two classes: 1st. Functional relations or connexions, arising from the necessity of the functional actions of the organs in every act of life: and 2d. Sympathetic relations or connexions; or the influence ex-

ercised by one organ on another independent of its functional acts or of a mechanical operation.

Besides the above connexions, the organs exert often an influence on each other, which is entirely mechanical or physical. Thus the stomach, when over-distended with flatus or food, presents an obstacle to the descent of the diaphragm in respiration, and occasions a sense of suffocation. This is more especially experienced in organic diseases of the heart, pericardial dropsy, hydrothorax, and when the lungs are in a state of solidification. The pressure of the distended uterus exercises a mechanical operation, deranging often the circulation of the lower extremities, the functions of the bladder, of the abdominal, and even thoracic viscera, more particularly when in a morbid condition.

The muscular organs exhibit many instances of this mechanical influence, especially in the pathological state. The movements of the muscles when the aponeuroses covering them are inflamed, as in rheumatism, cause most severe pain, which has led to a supposition that the muscles themselves are affected in that disease. The motions of the chest in respiration, coughing, &c. when the pleuræ are attacked with inflammation, aggravate highly the sufferings of the patient, and increase the disease. Nature interferes for the benefit of the economy, and the thoracic movements are suspended—respiration is accomplished by the diaphragm and abdominal muscles exclusively. It is the movement of the diaphragm, the action of which cannot be dispensed with in respiration, that renders diaphragmatic pleurisy so formidable an affection, and so terribly distressing to the patient.

The abdominal muscles offer similar examples. In peritoneal inflammation the pressure from the contraction of the muscles heightens the sufferings of the patient. To relieve himself from this cause of pain, the lower extremities are drawn up to admit of the relaxation of the muscles of the abdomen. For the same object they do not participate in respiration, which is then chiefly performed by the muscles of the thorax. Precisely for the same purpose, in intestinal peritonitis, the peristaltic movements of the intestines, which, in the altered condition of the peritoneum, would prove injurious, is suspended, and costiveness prevails. The violent movement of the intestines excited by active purga-

tives, is thus shown to be counter-indicated, and should not be employed.

Muscular contraction exerts an influence over the circulation. It propels the blood with greater rapidity into the larger vessels, and throws it consequently in greater quantity, and in a more rapid manner into the heart and respiratory apparatus. Hence results the inconvenience, the distress, the aggravation of all the symptoms in patients labouring under organic disease of the heart; or when the capacity of the lungs is diminished by tubercular development, by hepatization, or by effusion into the pleuræ from all exertions. The indiscriminate recommendation of active exercise in pulmonary affections, and diseases attended with pulmonary symptoms, is often productive of much mischief.

The circulation manifests some mechanical influences. This is evidenced in the effect of position on inflamed parts. When depending, so that gravity prevents the more speedy return of the blood, the disease is more severe and more difficult of cure. It often suffices, by relieving the circulation by a change of the position, for the local affection to be dispersed.

In all the foregoing examples, the influence exerted by one organ or function on another, is exclusively of a mechanical character. They are of sufficient importance to be noticed, and should never be overlooked by the practitioner; but they are of less general influence, application, and importance, than those of the functional and sympathetic relations now to be considered.

Section I.—*Functional Connexions.*

The functions of the organs are the means of existence: it is by the actions of the organs, the organism is perpetuated and maintained in vital activity. All the organs and functions do not possess an equal efficiency in this respect; for, while on some the existence of the individual is immediately dependant, others may be suspended a length of time, without involving danger, and their destruction proves ultimately fatal only after a considerable period.

The functions the most directly essential to life, belong to the class of the organic functions, which are charged with the conservation of the animal economy. The end of all these functions

is the acts of nutrition, which are the essentially vital actions, for these are always formative, or modifying of structure, and the functions take rank in the offices of organic life, according to the intimacy of their connexion with the nutritive actions. But the presence of oxygenated or arterial blood is an absolute condition for the persistence of the vital and nutritive actions in every tissue. When black or deoxygenated blood penetrates into the tissues, their vital actions immediately decline, and soon terminate, and the organs die in proportion as they are invaded by venous or black blood. In what manner oxygenized or arterial blood acts in supporting vitality, or in what mode venous or deoxygenized blood proves fatal to vital activity, are questions, which, though evidently of the highest consideration, have attracted the attention of but few physiologists. Their intrinsic difficulty most probably discourages attempts for their investigation by experimental means, and analytic observation alone to be relied on; and, in our present state of knowledge, they may be regarded as placed nearly beyond the pale of philosophic research. The most common conjecture assigns to arterial blood the mere action of a stimulant, essential to the maintenance of vital activity, and assumes that venous blood, destitute of any positive deleterious qualities, is incompatible with the vitality of the organs, solely from its incapability of exciting their actions. This view is unquestionably too limited, and has been shown by Bichat to be incorrect. The development of organic force or excitability, which occurs in the formative act of nutrition, appears to be connected with, and dependant on oxygenized blood; and death from the penetration of venous blood into the organs, is a result of the loss of the organic force, or excitability of the tissues.*

The presence of arterial blood in the organs being one of the essential conditions of the organic actions, the functions preparative of this fluid, and distributing it throughout the economy, must exercise a predominant influence over the organism, and hold it in an obliged dependance.

I. Respiration is the function, in the processes of which arterial blood is prepared. It passes from the lungs into the left or systemic heart, and is thence thrown into the various organs and

* Page 112.

tissues of the economy. When this function is interrupted by the air, in any manner being prevented from entering the lungs, or air containing no oxygen is introduced into them, the venous blood is no longer converted into arterial, but passes into the systemic or left heart, and thence spreads throughout the organism its lethiferous influence. The brain and spinal marrow are no sooner penetrated by this deadly fluid, than they cease to live, and the sensibility, the muscular motions, and other functions depending on the nervous system, are annihilated. The heart, when blood in this unchanged state has reached its interior structure, through its vessels, loses its capacity of being excited, its contractions are suspended, and the circulation terminates. A new source of death thus arises from the destruction of the movements of the blood. This state arising from the presence of black or deoxygenated blood in the organs, is termed *asphyxia.* The constant supply of arterial blood to the organs being a condition of their activity, respiration, the function executing hæmatosis, or the formation of arterial blood, is a vital function, the regular performance of which is a requisite for the performance of all other functions, and thus holds them in an immediate dependance. The lungs, consequently, are a centre of vitality, influencing directly the heart, the brain, and the various organs of the economy.

II. Respiration is accomplished by movements executed by various muscles. But these are excited and kept in action by nervous stimulation, derived from the superior portion of the medulla spinalis and oblongata. Respiration is consequently made to depend on the integrity of these organs. Disorder of these will cause disorder in the performance of this function; and profound lesions of those structures, incompatible with their activity, will prove destructive of respiration, and through this function occasion the death of the whole organism. The medulla oblongata is thus also a centre of vitality, whose active influence is essential to the continuance of vital activity.

III. Oxygenated or arterial blood, whose presence in the organs is a condition of their activity, is distributed to them by the heart, the central organ of the circulation. The arterial blood formed in the lungs, arrives from them in the left or systemic heart, whence it is propelled through the arteries into the capillaries, where it is placed at the disposition of the various organs

and tissues, to be employed according to their demand and want. The movements or circulation of the arterial oxygenized blood or nutritive humour, is consequently depending on the heart and arteries, the organs of supply. If the action of the heart ceases, the capillaries, the organs and tissues into whose composition they enter, cease to receive their supplies of arterial blood; their organic actions, no longer supported by the vital fluid which sustains them, immediately decline and are soon extinguished.

When the movements of the heart are considerably enfeebled, the brain is not supplied with arterial blood in quantity sufficient for the exercise of its various offices; they are suspended for a time, and the whole organism manifests the most extreme debilitation. This state constitutes *syncope,* which proceeds always from enfeebled action of the heart and diminished energy of the cerebral functions.

The heart is, in this manner, a third centre of vitality, whose integrity is necessary to the healthy performance of all the functions of the economy, and on the continued exercise of whose office, all the organs are held in an immediate dependancy.

The lungs, the medulla oblongata, and the heart, are organs connected by the most intimate ties, whose offices are reciprocally essential to each other, constituting a circle of vital actions, and with which all the organs and functions of the economy are held in a concatenation the most absolute and direct.

IV. The foregoing functions are those immediately engaged in the distribution of the arterial oxygenized blood or nutritive humour, the incessant arrival of which in the intimate structure of the tissues is the indispensable condition of vital activity and phenomena. But this fluid, constantly consumed in the acts of nutrition, requires the supply of new materials, which are derived from matters exterior to the organism. These matters, always uniform as to their nature and composition, prepared by the processes of digestion—chymosis and chylosis—are absorbed and conveyed into the sanguine circulatory apparatus, are there transformed into blood, and thus compensate for the loss it has sustained. But the stock of sanguine fluid is always considerably greater than the immediate demand, and consequently the functions of supply, or those of digestion, are of less imperative necessity than the foregoing. They may even be suspended for

considerable periods without entailing a fatal result. The digestive functions, notwithstanding, exercise a most decisive influence over the composition and the condition of the blood, both as it respects its quantity, which must depend on the regularity of their performance, and its constitution or qualities, resulting from the mode in which they are performed.

The organic and nutritive principles of the blood are exhausted in the nutrition of the solids and the production of the secreted fluids, and if not renewed by the functions of digestion and absorption, the composition of the tissues and organs of the economy declines, is deteriorated, and finally terminates. The interruption of these functions for any length of time, proves of course fatal, from the deficiency of the nutritive and organic elements of the vital fluid, and the necessary alteration in the structure of the solids, incompatible with their state of vitality.

Care must be taken not to confound inanition—the waste of the solids and fluids, resulting from the impoverishment of the sanguine nutritive humours, an effect of prolonged abstinence, with the symptoms and effects arising from intense gastric irritation developed in many individuals by the pain of hunger and thirst, and who die from this cause and its consequences, and in a manner different from those who succumb solely from the defective state of the circulating fluid.

The blood is further affected in its characters and constitution by the manner in which digestion is performed, and the qualities of the aliment.

When this function is executed imperfectly, chyle cannot be properly elaborated, and the renovation of the blood and the reparation of the solids will prove defective. An alimentation deficient in nutritive principles or deteriorated in its qualities, will be productive of a chyle devoid of the elements necessary to the constitution of healthy blood, or contaminated with principles noxious to the organism.

Many substances also in whose composition enter principles that are inorganic, resist the digestive processes more or less completely. These principles enter the circulation, exist there with their foreign characters, penetrate with the sanguine nutritive humour the interior of the solids, and modify their actions

or mode of being in diversified manners, according to their activity and the relationship they bear to the different organs.

The digestive functions, it is thus apparent, affecting the quantity or quality of the sanguine nutritive fluid, possess an extensive relation, though less direct and immediate than respiration, respiratory innervation, and circulation, with nutrition, and all the organic functions of the economy.

V. The function of absorption, from its connexion with the formation of the circulating and nutritive fluid, influences remotely most of the other functions, and involves in its operations the state of the whole organism, often profoundly affected through the exercise of this function.

On chylous absorption it is unnecessary to dilate. The constitution of the blood has been shown to depend on its regular performance. The obstruction or obliteration of the thoracic duct, which has sometimes been observed, is always a fatal accident; death ensues from inanition. The symptoms exhibited in these instances differ from those manifested in starvation, as the stomach, supplied with aliment, does not suffer from the irritation developed by the pain or stimulation of hunger.

The cutaneous and pulmonary absorption exert no other influence over the blood, than the occasional introduction into it of foreign and often morbific emanations, which, contaminating this fluid, subject the organs to their deleterious influence. Miasmatic exhalations, contagious poisons, and some gases that have a positive action in the production of asphyxia, develope their morbific powers in this mode.

It is in this manner also that the therapeutic operation of certain remedial agents can be procured, by inhalations into the lungs, or their application to the external surface, especially when the epidermis is removed.

The internal absorptions are not much less effective in influencing the blood, and through it the other functions. Venous and lymphatic absorption return into the circulation the fluids distributed into the tissues through the arteries, combined with the recremental principles proceeding from the decomposition of the solids, which are the materials of the excretions. The suspension of venous absorption, which occurs in extreme conges-

tions, accumulating and arresting the blood in large and vascular organs, or extended surfaces, by withholding it from the general circulation, occasions all the effects of exhaustion in the movements of the heart. The extremest debilitation prevails, the pulse vanishes or is scarcely to be perceived, and the functions of the organs not included in the morbid accumulation, are reduced to the lowest state, from the deprivation of the quantity of sanguine fluid required to sustain their vital activity.

The internal absorptions sustain for a limited period the nutritive functions, when the supplies of exterior materials are cut off, by the failure of the digestive processes or external absorption. The excess of nutritive organic elements, reserved in the form of fat, interstitial and cellular fluids, is then taken up, conveyed into the circulation, and continues the reparation of the sanguine fluid. The quantity and qualities of these materials influence the constitution of the blood, modify its character, and consequently the condition and action of the solids generally.

Foreign matters sometimes find admission into the circulation through this route, and subject the organism to their influence. The bites of venomous reptiles, of rabid animals, and the wounds of poisoned weapons, introduce, in this mode, principles of excessively deleterious and often fatal activity.

VI. The general circulation is a common reservoir into which are poured the products of internal and external absorption. The blood, consequently, is contaminated with the recremental materials of the decomposed tissues, with foreign unassimilable substances incompatible with organization, and often hostile, from their properties, to the structure, and other matters whose presence deteriorates its healthful constitution. The depuration of this fluid is a measure of necessity, and is accomplished by the excremental secretions—the urine, the cutaneous, pulmonary, and intestinal exhalations, and perhaps the bile.

The secretory functions, in their regular exercise, influence in a positive manner, the production of the sanguine nutritive fluid; and their derangement or suppression, affecting its qualities and depraving its nature, modify through it the actions of the solids, the general functions of the organism, and may prove eventual of fatal injury.

The preceding functions are immediately connected with the

formation and elaboration of arterial oxygenated blood, or the sanguine nutritive and organic fluid, and its supply to the different organs; and they exercise an influence more or less direct and positive, not only over each other, but over the organic or vital actions, and the vital activity of the whole organism. This influence is, however, in all instances, resolvable into the law which was announced in the introductory remarks of this chapter—that the presence of arterial oxygenated blood in the tissues and organs is an absolute condition of vital phenomena in the superior animals.

VII. Nutrition, which is generally classed with the functions, is more properly a vital action, immediately connected with the organic actions. Being dissimilar in the different organs, and possessing varying degress of activity in the different tissues, relations in these respects of great interest are established, affecting deeply the mode of being of the organs, and the performance of their functions.

The organic actions, the nutritive actions, and the capillary interstitial circulation or movements are concatenated so intimately as to be incapable of separation; and whatever is established as true of the one, is applicable to the phenomena of the others. The organic and nutritive actions being a molecular movement or play of affinities between the solid elements and fluid elements of the tissues, they cannot be augmented without a concurrent augmentation of the capillary circulation and sanguine fluid in the tissue. The capillary interstitial circulation, if excited into increased activity, must cause a corresponding change in the organic actions and nutrition. But these, it is an established proposition, are called into action, and are maintained only by excitants or stimuli. The development of an excitation in a tissue, or the operation of a stimulant on it, is, consequently, an enhancement of its organic and nutritive actions and its capillary interstitial circulation—an exaltation of its vitality. This state, suffered to persist for any length of time, must terminate in some change of the structural constitution of the tissue, and a modification of its vital properties, mode of being, and phenomena. This is the source of danger in permitting inflammations to become chronic, and to this cause it is that chronic inflammations are so resistive to the operation of remedies, and so often intractable to remedial treatment.

The relation existing between the organic and the nutritive actions, and the capillary interstitial circulation, is thus seen to be of the most intimate character, and the state of the one necessarily causes an analogous corresponding state of the others.

The capillary system and interstitial structure is continuous and communicating through the whole organism. When an excitement, beyond a normal degree, is developed in a tissue, and invites or calls into that tissue supplies of blood adequate to the maintenance of the augmented organic actions, or the stimulation induced, a general movement of the blood, contained in the capillaries, is then put into action, and directed towards the point of irritation, commencing with immediately surrounding tissues and organs, and finally extending to those more remote. In this mode it is that every seat of irritation is a focus of affluxion, in which the blood is accumulated, while organs and tissues the most remote are exhausted of their circulating fluid, have their organic and nutritive actions consequently enfeebled, and their vital activity debilitated. By this process are congestions formed, which exist, and can only exist in the capillary and interstitial structure, and result from the movements of the capillary and interstitial circulation, and do not exist in veins, or are an effect of venous circulation, as has been assumed by writers of distinguished reputations: and by this process are produced the violent disturbances and perturbation so often existing in the circulatory movements of the organs, and the extreme disorder of the functions, overthrowing the balance which holds the circulation in equilibrium amongst the organs, and constituting so prominent and distinguishing a feature of cholera, of algid intermittent, and similar maladies.

The influence of the heart and general circulation over the capillary circulation and organic and nutritive actions, has been commented on. These last exercise again a reciprocal influence over the heart and general circulation. When irritations are excited in extensive surfaces, and form congestions, the accumulation of blood in them, and its abstraction from other organs and tissues, exhausts the blood of the general circulation. Retained in the capillaries of the irritated tissues, it is withheld from the general circulation; the heart, missing its normal stimulant, fails

in its action, the pulse becomes feeble, or may even disappear, and the organs, exempt from the irritative actions, sink into the debility of inanition.

The phenomena attending the onset of acute irritations or inflammations, picture in striking colours this state. The commencement of acute thoracic and abdominal irritations, from the concentric movement imparted to the capillary fluids and circulation, is attended with coldness, chills and rigors—the external surface of the body is pallid, shrunken, cold; suppurating ulcers, issues, urethral secretions dry up; the pulse is contracted and weakened, while sense of heat, oppressed and disordered function, pain, and morbid irritability, or pathological force, prevail in the internal surfaces and organs. Every fact announces, in language not to be misunderstood, that the periphery and the brain are abandoned by their fluids and vital forces; that the general circulation is exhausted, and that the internal organs and surfaces are suffering from excess of their circulating fluid and vital activity, threatening their structural integrity and functional exercises.

From the diversity of elements, tissues, and organs composing the economy, each having its own mode of being, sum of vitality, and amount of sustaining vital fluid, drawn from a common reservoir and a limited stock, a balance is established between the different tissues, organs, and surfaces; they antagonize each other with opposing forces. When these are in equilibrium, each organ and tissue, possessing its appropriate excitement, activity, and quantum of circulating fluid, vigorous health prevails, and while this equilibrium continues disease cannot exist. Its maintenance is the great law of hygiene and of prophylactic treatment. The essential feature of the pathological state is the disturbance of this equilibrium, the overthrow of the balance distributing in appropriate proportions the circulating fluids and forces of life, establishing the permanent ascendancy of one portion of the organism over another—inflammations;—or impressing fluctuating movements of greater or less rapidity towards particular organs—raptus, molimen of older writers—and thus creating the phenomena of paroxysmal and periodical diseases. The law of balance, the antagonism of action and force ruling the organs of the economy dis-

played in the preceding facts and considerations, are a result of the continuity and universal connexion of the capillary and angeal interstitial structure, and the mechanism of the organic or nutritive actions. The first renders the whole capillary and interstitial circulation, or sanguine movement, liable to receive a direction, or to be influenced by movements impressed on one portion; and the last, by its power over the capillary interstitial circulation, will accumulate the sanguine fluid where they are excited into unwonted activity, at the expense of the circulation, of the nutritive or organic actions and vitality of other organs or tissues. In this manner is the natural balance, equalizing the activity of the various organs of the economy, and maintaining their functions in healthful exercise, disturbed and overthrown. The efforts for the restoration and maintenance of this natural equilibrium when it has been shaken, gives rise to the phenomena of reaction, creates paroxysms—and the capacity of resisting its disturbance, and preserving it in due adjustment, depends on a general diffused tonic excitement or invigoration of the capillary movements and nutritive organic actions.

VIII. The functions of relation, though of the most elevated order, and to the existence of which all the other functions may be regarded as subservient, and called into being, are not as immediately necessary to individual existence as are those of nutrition, or the organic functions. They are implanted on the functions of nutrition; they impart the capabilities of social existence, and the elevation to high destinies by the endowment of moral and intellectual faculties; they connect the being with the various external matters and agencies which constitutes the universe. But the actions of vitality are, in themselves, independent of the functions of relation, as is seen in the lower animals and in vegetables; and even in man and the higher animals may exist for a considerable period after the functions of relation are annihilated.

These functions are, notwithstanding, closely connected with those of nutrition, and exercise a most decided influence over the actions and offices of different organs. It is by sensibility, and the perception of the transmitted impressions, that the states of the surfaces, and the condition of organs which announce the wants, and constitute the interests of the individual, are recognised, are made known, and the acts of volition called into requi-

sition for their gratification and relief. The loss of sensibility, by suppressing the power of perception, and destroying the peculiar sensations of the different organs, prevents the intelligence from acquiring the cognisance of the wants of the organism, and it is in consequence exposed to destruction.

In another relation are these faculties connected with those of nutrition in a still closer association. The reparative elements of the economy are derived from exterior matters. But it is acquired knowledge that makes known their properties, uses and preparation, and they are to be obtained only by the voluntary acts of the individual. The mental and physical imbecility of infancy utterly preclude the possibility of either knowing the proper matters for aliment, or performing the acts to obtain or prepare them. Abandoned to themselves, infants of necessity perish. They find, however, protection in their helpless state, from the innate moral faculty implanted in the parent as a part of the being, inspiring love of offspring, not as a conventional arrangement, or as depending on the casualties of education, but impelling with the force of nature, and the energy of an instinctive want, to all the acts required for its conservation, its enjoyment, and its happiness.

Disease affecting the faculties of relation, and destroying the powers of voluntary motion, incapacitate the individual from the procurement of the supplies his wants render necessary. The functions of nutrition are thus dependant on those of relation for the means of their exercise, and the existence of the whole organism ultimately depends on their continued performance and healthy condition.

The moral faculties with which man is endowed to constitute him a social being, and which give to him the adaptation for civil and political life, exert often a most potential influence over various organs and functions, particularly when acting with the intensity called *passion*. So powerful is frequently their perturbating operation, as to occasion deep-rooted affections, lasting derangements of important offices, and even to be productive of sudden death. The heart, the capillary circulation, the stomach, the liver, the bowels, the kidneys, the lungs, all manifest in various modes the power of the passions over their functional actions. Of these passions some are exceedingly exciting; they

exercise an expansive power over the movements of the sanguine fluid, animate and invigorate the organs in their operations, imparting new force and vigour to the actions of life. Others are of depressing character, concentrating the sanguine fluid by a concentric movement, disposing to its congestion and stagnation, oppressing the functions of important organs, prostrating the energies of life, and unfitting the economy for the performance of its healthful offices.

The functions of relation exert their influence over the organic functions, in consequence of the union of the nervous organs of the cerebro-spinal apparatus, and of those of the ganglionic apparatus. They are not, however, indispensable to the exercise of the nutritive or organic functions. Many animals possess no brain; in others, as the helix, if removed, it will be reproduced; and in reptiles, though when destroyed it is not again formed, yet they will survive for a considerable period its entire destruction. In the more highly organized animals, the sudden destruction of the brain, or violent injuries sustained by it, are followed by speedy death; but this is no more than occurs from similar accidents happening to other organs, and even to the limbs, when crushed with sudden and great violence. In disease the brain often suffers extreme lesions, and the functions of relation, the psycological faculties, are completely suspended, or even annihilated, and the individual, if his physical wants be supplied by extraneous assistance on which he becomes dependant, may still continue to exist. But the progress of destruction being slow, the organism is adapted to this new state, and is enabled to continue its being, though in a degraded or lower scale of vitality. I knew an instance of this kind, in which the individual survived between five and six years, the total extinguishment of the cerebral functions, maintaining a mere vegetable organic existence, unconscious apparently of the exterior world or its relations.

The functions of relation, besides the influence they manifest over the nutritive or organic functions, exhibit a series of close and mutual connexions with each other. These functions are of various orders—sensibility to receive impressions; perceptive organs to which impressions are transmitted, and in which they are repeated, forming ideas; reflective faculties, comparing, combining, and deciding on impressions or ideas.

The development and exercise of the functions of relation, like all the other functions, are accomplished by the excitation of exterior impressions. These are received on the nervous expansions in the organs of the senses, external and internal, and are transmitted to the central organs in the encephalon by the nerves. Now, sensibility, the nervous principle that imparts the capacity to receive impressions, is connected with and dependant on the organic structure of the nervous expansions, and the impressions transmitted to the organs of the brain, adapted to each particular kind of impression, give origin to ideas, the subjects on which the higher or reflective, comparing and combining faculties are exercised. But the organization of the nervous expansions, and of course sensibility, vary in different individuals. When obtuse or defective, the impressions of exterior agents are less active, the ideas they excite are imperfect, inaccurate, and all the results of the reflective faculties acting on them are necessarily more or less erroneous. The difference in the sensibility of individuals, the greater or less accuracy of their perceptions, are principal causes of the contrariety of opinions formed on the same subject, the diversified manner in which it is viewed and comprehended, and of the judgments deduced from the same premises. The functions of relation, the intellectual faculties, are thus dependant, to a certain extent, for the activity of their exercise, and the mode of their action or sensibility, on the organization of the nervous expansion in the sensitive surfaces and organs, the first recipients of external impressions. Precisely in the same manner are the instincts, the propensities, and, in some instances, the affective faculties, in a dependance on the stimulations of the internal senses and the viscera. Other connexions and mutual dependencies of the functions of relations exist, and would be exemplified, but, as the object is merely to indicate a general fact, consentaneous with a universal functional law, it is not necessary to enter into more minute details.

Section II.—*Sympathetic Connexions.*

The organs are the seat of two classes of actions—*functional*, which are the offices of the organs destined to specific objects,

and differing in each organ; and *organic*, or the nutritive vital actions, which are common to all the organs.

The first give existence to series of connexions arising out of the necessity for the function of each organ in the economy, the cooperation of one function to the maintenance of all. The exposition of these connexions occupies the preceding section.

The second called into and sustained in action by the impressions of exterior agents, and liable to incessant variations in each organ from the operation of numerous influences which affect them, another series of connexions is thus established, exclusive of the functions, and dependant entirely on the organic actions. This last series of connexions, or relations, constitutes what is termed sympathy—συμπάθος—concurrence of affection—through which the condition of one organ is extended to others, and made common to many, by which the suffering of any one organ is proclaimed, and the force of the whole organism brought to its rescue.

The connexions established by the functional and sympathetic relations, bestow a unity on the organism, and impart a regularity of movement to the complex mechanism of the animal economy. From these connexions proceed the harmony that pervades the actions of all the organs, and their joint cooperation to one object—the conservation of the individual and maintenance of vital activity. A common consent is thus established, uniting every part by the closest ties in health and in disease, a fact long since recorded by Hippocrates—*consensus unus, consentia omnia.*

A knowledge of the sympathetic relations is indispensable to the formation of a sound and enlightened practitioner: it is essential to the elucidation and correct understanding of pathology and therapeutics. Without this knowledge it is not possible to separate accidental symptoms from those which are constituent; to distinguish, amid the disarray of all the natural offices of life, the secondary or sympathetic affections evolved in the course of disease from the primordial, and thus to arrive at once at the origin and fountain of the disorder. Without this knowledge it is likewise impossible to discriminate the events, the necessary concomitants of the disease in its progress, and the products of morbific causes, from those which emanate from the remedies employed, perturbating in their operation, producing actions of

the same order with those that are pathological, and readily confounded with the disturbances, which are exclusively morbid, an error too common, vitiating the results of observation, and tending to weaken confidence in what is called experience.

The mere annunciation of a fact, without an investigation of all its attending circumstances, contributes but little in rendering it available to practical objects. For this purpose it must be examined in all its bearings; its nature, its mode of production and action, its influences, and the ends for which it is designed, be investigated and determined. With this view it is now proposed to enter into an examination of what sympathy is—the apparatus or organs that give it existence, the mode of its production, the useful purposes attained by it, and the laws of its government.

I. Since medicine has been cultivated as a science of observation, it has been universally recognised as a fact, that an organ, in which a pathological state has been induced, will cause the same condition in one or more remote organs, those that are intermediate remaining unaffected. To the cause productive of this fact is applied the term sympathy. It is an established phenomenon of most extensive application. The extension of actions by sympathy is wholly independent of the functions of the organs. Inflammation, or acute irritation of the gastric mucous tissue, will excite the same mode of action in the brain or its meninges, inducing delirium, or coma, or stupor, or convulsion, or apoplexy, according to its intensity and extent. This action of the stomach on the brain, is entirely unconnected with its function, digestion —but results from a direct transmission of the irritation or action existing in it to the brain and its communication to that organ. The functional actions are deranged, but that is secondary to the primitive affection, which is a preternatural or disordered state of the organic actions. It is these last which alone are the subject of the sympathies. Functional actions are not embraced in the domain of sympathy, and the disorder of a function cannot be communicated to another organ by sympathy. One function is made to depend on another, and will be thrown into disorder when that other is not exercised in its healthy mode, but this relation has no analogy with sympathy. Sympathetic relations exist exclusively with the *organic actions*, and are the means correcting and equallizing them throughout the organism.

This definition of sympathy, by giving precision and a positive value to the term, restricts very considerably its application, and reduces very greatly the list of the sympathetic phenomena. A number of phenomena which have been regarded as belonging to the category of the sympathies, must be separated from them, and be referred to other classes to which they more properly belong.

Tissues that are continuous, and organs that are contiguous, exhibit some relations, classed by J. Hunter, with the sympathies. An inflammation of the skin will often traverse a considerable portion of that membrane, invading one part, and abandoning another. This has been called the *sympathy of continuity*. But it is evidently a phenomenon entirely different from that which connects remote and distinct organs and tissues, to which the term sympathy should be exclusively applied, that things totally dissimilar may not be confounded.

An irritation or inflammation excited in the rectum by making it a point of adfluxion for the capillary movements, by directing the blood towards the pelvic viscera, will often cause an excitement of all those organs. Or a sedative application, as of cold, applied partially to the surface, will diminish the activity of the vital movements in the subjacent contiguous organs and tissues. This influence, arising from the contiguity of parts, and proceeding from the universality of the capillary tissue in the organism, has, like the preceding, been incorrectly ranked amongst the sympathies by the name of *sympathy of contiguity*.

Another set of phenomena connected with the function of the capillary movements or circulation, has been improperly attributed to sympathy. A debilitation of the vital activity of an organ or tissue, by diminishing its demand on the general mass of circulating fluid, produces often excited activity in other organs or tissues from the augmented quantum of the circulating fluid they receive, or partial plethora thus induced. Cold acting on the exterior surface, by its sedative influence, enfeebles the organic actions, or vital movements existing in the skin. The demand, consequently, of this extensive tissue on the general circulation for supplies, is diminished one-half, or two-thirds, and this amount of blood is thrown upon some of the internal organs or tissues, causing in them various shades of irritation, acute in-

flammations, congestions, apoplexies, or hæmorrhages. These various effects will depend on the degree of excitement of some particular organ or tissue, which makes it the point to which the surplus circulation is directed, and degree of asthenic torpor in the skin reducing the extent and quantity of its circulation, and thus augmenting the internal sanguine repletion. The affections arising in this manner have been ascribed to sympathy, which, with perfect contradiction, has been called *reverse sympathy*, as though a sympathetic affection can be the reverse of the primitive. Because bronchitis, pneumonia, and pleurisy, inflammatory affections, are the consequences of cold sedatively depressing the external surface, it is said a reverse sympathy prevails between the skin and the pulmonary organs. But these phenomena are to be ascribed to the law of antagonism, or balancing of the organic actions and capillary movements, which has been indicated in the preceding section.

Sympathy is the medium connecting the organic actions of the different organs, and consists in the transmission to a remote organ, and the repetition in that organ of the same mode of action which had been previously excited in some other organ. One organ is in this manner an exciter or stimulant to the actions of other organs, and concurs by this means to the maintenance of the vital activity of the whole organism.

II. Various of the tissues have been conjecturally assigned at different times as the medium or the organ of the sympathies. The improvement of physiological knowledge, by determining in a more precise manner the offices of the different tissues and organs, renders it certain that the nervous apparatus alone is capable of producing the phenomena to which the term sympathy is applicable. No other portion of the structure manifests phenomena of a similar order; and in the nervous apparatus we possess natural phenomena perfectly analogous to those of the sympathies.

In the senses we have the positive demonstration of the transmission of impression from one organ to another distant organ. The impression of visual rays on the retina, ærial vibrations on the expansions of the acoustic nerve, of tactile bodies on the nervous expansions of touch, are transmitted to, and repeated in the central organs of the brain, appropriated to those particular

senses, and thus impart the especial sensations of seeing, hearing, and feeling. That the sensations consist in the repetition of the external impression or stimulation of the external nervous expansion in the central cerebral organ, is clearly shown by the phenomena of disease; for, whenever an excitement is developed in those organs, sensations exist as perfect as when they proceed from the actual impression of the external cause on the external organ of the sense or nervous expansion. The hallucinations of the different senses are the consequences of this excitation of the cerebral organs. The individual sees objects, hear sounds, feels the touch of substances, tastes or smells, with a sense as perfect, as complete in every respect, as when the organs of these senses are immediately excited into action by their specific modifiers; and these sensations are experienced in the external organs themselves, the same as though the external objects were in action on them. A reciprocity and identity of action, it is apparent, prevails between the organs of the senses on the external surface, the recipients of external impressions, and the internal cerebral organs; an action excited in the one being transmitted to and repeated in the other. By this arrangement the brain, securely placed, and protected from accidents by its interior location, is, notwithstanding, placed in direct relationship with exterior agents, and receives, as it were, their immediate impressions. In this example of the senses we have presented a series of phenomena corresponding exactly with those constituting the sympathies—an action excited in one organ transmitted to and reiterated in another.

Illustrations of a yet stronger character are furnished by the phenomena of the nervous apparatus, exemplifying in a more vivid light the character and mode of production of the sympathies. It may be alleged, of the instances of the external senses, that the external and internal organs of the apparatus of the senses are so nearly similar they may be almost regarded as one organ—the external organ being an extension of the cerebral organ to the external surface—and, consequently, in the phenomena of the senses there are in reality but one organ, one impression, and one action. But we are presented with other series of phenomena connected with the nervous system to which this objection is not applicable. A mental impression, an idea, the excitation of a moral emotion, excites or

modifies the movements of the capillary circulation, or disturbs the regular function of some important organ. The deep suffusion of the mantling blood in the face and neck of a modest female, the eloquent language of the unuttered thought, is a striking exemplification of the influence of cerebral excitement over the capillary circulation. The effects of the passions on the heart, so frequently disturbed in its mode of action by moral emotions; the disorders of the biliary secretion, and derangement of the digestive action of the stomach, induced by profound mental operations, are strong evidences of the transport of impressions by the nervous system. A still more impressive example is found in the erotic ideas, in dreams, so stimulating the genital organs as to provoke in them the actual sensations of the venereal act, and the ejaculation of the seminal liquor.

In these examples is manifested an excitement transmitted by nervous communication from one organ, in which it is developed, to another organ to which it is transported, and to which it is imparted. It may, then, be regarded as a positive fact, that the nervous tissue possesses, as a functional capacity, the power of transmission—a species of radiation—by the action of which an impression, a stimulation, a mode of activity, imparted to a tissue or organ, is communicated to distant organs or tissues. By this process an equalization of force and activity, according to the properties of the tissues, is maintained, and a community of impression and action is established, in the complex mechanism and dissimilar structures of the animal organism, creating in it the beautiful cooperation, harmony, and order, necessary for the performance of its multiplied functions, and its preservation against so many aggressive causes incessantly threatening its healthful existence.

The power of transmission is common to all the nervous apparatus, and is the means connecting its different portions. But, for the transmission of the excitement of the organic actions, a specific nervous apparatus is provided—it is the ganglionic system, or the sympathetic—the nervous system of the viscera and organic life. By the arrangement and distribution of this system, a nervous apparatus is provided, independent of, yet most intimately connected with the cerebro-spinal nervous system. It is endowed with the same force, nervous activity, fluid, or what-

ever name it may be known by. It possesses an analogous mechanism; nervous organs or centres—the ganglia—nervous cords of communication or of transmission, and receptive expansions in the viscera. Its actions and influences are in a similar mode—impressions received, excitement of nervous activity, and transmission of excitement—and it exercises a controlling and governing influence over all the splanchnic viscera, to which it is distributed, similar to that exerted by the cerebro-spinal apparatus over the organs of locomotion, expression, sensation, the intellectual and moral faculties.

It was announced precedently,* that in the cerebro-spinal apparatus of the functions of relation, a central point exists, located in the medulla oblongata. To this point all the nerves of this apparatus are directed, towards it are transmitted all the impressions received by their expansions, or are excited in the cerebral structure, and from it are reflected again as from a radiating focus, the movements of nervous stimulation excited in the various organs, with which it has relation.

A similar central point appears to exist in the ganglionic apparatus, or organic nervous system. This centre is the semilunar ganglia and solar plexus, seated in the dorsal portion of the epigastric region, and distributing nerves to the stomach, liver, spleen, small and large intestines, kidneys, spermatic vessels, and diaphragm. All the impressions which reach the internal surfaces, all the excitations developed in them, and any of the viscera, are transmitted to this centre, are repeated in it, and reflected into the other viscera with which it is in communication. This centralization and redistribution of impressions and actions, place the viscera in the closest relations with each other, make the impressions and modifications of action induced in one, common to many, and constitute the ganglionic apparatus the material organ of the sympathies, of which the semilunar ganglia and solar plexus, as possessing the most extensive connexions, are the principal, central, or governing portion.

The existence of this centre of visceral impressions and actions has been recognised, though not properly comprehended, from remote periods, and has given origin to various hypotheses

* Page 33.

connected with it. The ruling power *archæus* placed in the stomach, the *phrenic*, the *epigastric centre*, the *diaphragmatic influence*, and *abdominal brain*, which have formed the basis of different theories, are evidences that observing and reflecting physicians have always been fully impressed with the fact, that the internal sensations, and visceral disturbances, were to be referred to the superior region of the abdomen as to a central point.

Two principal centres are thus perceived to exist in the nervous system, one attached to each apparatus—cerebro-spinal and ganglionic. We say principal, for they are not the sole and exclusive centres. Each cerebral organ of the apparatus of relation is a centre for the functional impressions and actions specific for that organ and its function; it is the terminating point of the nerves which communicate with it, the recipient of the impressions they convey, and the exciter of specific nervous stimulation. Each ganglion of the sympathetic is a similar centre, the recipient of specific impressions, and the exciter of specific actions in particular organs. But the medulla oblongata, the intermediate point in the apparatus of relation, on which is concentrated all the movements of impressions from the exterior to the internal cerebral centres, and from these again to the periphery; and the semilunar ganglia and solar plexus in the ganglionic or organic nervous apparatus, from their greater development and more extended connexions, become each, in its particular apparatus, a predominant centre, controlling the actions of all the others, and necessary to their existence.

The two important centres which have been indicated as existing in the nervous system, are immediately connected to each other, and by this connexion, the two apparatus are placed in communication, and direct relations established between them. This communication is accomplished by the eighth pair, par vagum or pneumogastric. Arising from the medulla oblongata, it sends branches to the ganglia of the neck and thorax, but is principally expended in anastomoses with the solar plexus and semilunar ganglia; so that it may be either described as proceeding from these ganglia and terminating in the medulla oblongata, or arising from this last it terminates in the ganglia.

The communication formed by the par vagum or pneumogastric, between the centres—the medulla oblongata and semi-

lunar ganglia—establishes the intimate relation and immediate connexion uniting the two apparatus of the nervous organs—the cerebro-spinal and ganglionic or organic. By this connexion impressions are mutually reflected from the one apparatus into the other; and consequently the impressions of the viscera, especially those of the abdomen, which have no direct communication with the brain, reach that organ, while those viscera experience themselves modifications from the influence of cerebral excitement. It is this circumstance that causes the intellectual and moral faculties to be affected so constantly in their exercise by the conditions of the digestive and generative organs, which occasions so many disorders of the locomotive apparatus to emanate from the same viscera, and which produces again in the functions of these viscera frequent disturbances, resulting from the commotions of the passions, powerful intellectual excitement or vivid impressions striking on the senses. In most instances, it is in the epigastrium, the region of the ganglionic centre, that is perceived a profound sensation, a sentiment of difficulty, often a feeling of pain, constriction, and sometimes of heat, preceding or accompanying cerebral disturbances; and every one is familiar with the existence of similar sensations in the same location, caused by the passions, by emotions of the mind, by particular ideas, or painful and disagreeable impressions on the senses.

The centre of the ganglionic or organic nervous apparatus, and the principal medium of communication with the nervous apparatus of relation being placed in the epigastric region, gives to the viscera which occupy it, and are in intimate union with that centre, the preponderating influence they are known to possess in the economy. The effect of concussion on this centre, suspending or annihilating its activity and power, similar to concussion acting on the brain, is the cause of the frequently fatal consequences of blows on the epigastrium. It is not the stomach which suffers, or a lesion of that organ which is destructive, but the semilunar ganglia and solar plexus, organs whose functions are so essential in the economy, have their powers suddenly destroyed, and are the immediate cause of death.

By the arrangement of the nervous system into two separate divisions with distinct centres, especial advantages are obtained. The cerebro-spinal apparatus, executing the functions of relation,

connects the animal organism with exterior objects and influences. The ganglionic apparatus unites the whole of the viscera, produces co-operation in their organic or nutritive actions, an equalization of their forces, and a concurrence of their functional operations in the maintenance and preservation of the animal economy. Without this arrangement of the nervous system, the viscera must have remained isolated, as in the inferior organizations of animals and vegetables, when, from the high degree of sensibility and irritability necessary to their offices, they would have been exposed incessantly to destruction from aggressive impressions, from which they could not have been rescued; or, had their combination been made to depend on the cerebro-spinal apparatus, they would have been liable to continual disturbances of their functions, from the influences of exterior impressions on the senses, the operations of the intellectual faculties, and the excitements of the passions. The connexion of the viscera in their nutritive or organic actions, being thus traced to the ganglionic nervous apparatus, it is that structure we must regard as the material organ of the sympathies.

III. In this review, having ascertained, 1st, that the known operations of the nervous system are alone capable of solving the phenomena of sympathy; and 2d, that they are especially the attribute of the ganglionic apparatus, we are now led to examine in a more particular manner, in what sympathy consists—what is the kind of action that gives existence to its phenomena.

At the threshold of this inquiry, we are met by an obstacle presenting a formidable impediment in the way of our research, and which materially embarrasses the attempt to attain positive results. We know not the nature of the power, principle, or agent, whose activity is productive of the phenomena of the nervous system. Various hypotheses have been assumed, explanatory of the problem. Vibration of nervous cords, nervous ether or gas, an imponderable nervous fluid, galvanic or electric agencies, have been proposed as the material means of producing the phenomena manifested in nervous structure. Of these it may be said—they are at best conjectures, and by their adoption we are not essentially aided in our investigations, or enabled to offer conclusions of a convincing character. By confining, however, examinations to the positive phenomena verifiable by observa-

tion, serious errors may be avoided, and results of a general and practical character be attained.

In the preceding section it was established, that the transmission of a mode of action is a recognised power of the nervous tissue. An action excited in the nervous expansions, is transmitted by the nerves to the central cerebral organs, and is repeated in them. This action, arising from the impression of external agents, is an excitement of the same order, in the same line, with pathological excitement, or irritation; for sensation is always produced by an irritation in a sensitive surface. When the neck of the bladder suffers from irritation, the sensation caused by a distended bladder, by the actual impression of the urine, is so acutely developed, as to call into constant action the instinctive efforts for the evacuation of that viscus. The same fact prevails in inflammation of the mucous tissue of the lower portion of the rectum, and hence the tenesmus or unceasing efforts for defecation, from the existence of the sense of that want.

The external senses present similar phenomena. How many kinds and degrees of sensation proceed from irritations of the skin? Developed in the labyrinth, what various sounds and noises torment the sufferer; and when in the retina, he is annoyed with the sensation of vivid light.

In these exemplifications, an irritation of a tissue causes the same kind of action and series of phenomena as an actual impression of an exterior agent. An irritation, or stimulation, the excitation of the organic actions, awakens the activity of the transmitting faculty of the nervous tissue, and is conveyed and repeated in the nervous centres, disturbing their mode of existence, and consequently, through them is reflected into other organs or tissues, with which those centres are in communication. This fact is displayed in the convulsions, which may be induced in highly sensitive individuals, by excessive tickling. A mechanical irritation is exercised on the skin, a lively sensation is awakened, the internal central organs of sensation are actively excited, violently perturbated; the disturbance extends into the organs of locomotion, is thrown into the thoracic and abdominal ganglia, whence proceed the violent instinctive and irrepressible muscular exertions, the painful visceral sensations of the chest and præcor-

dia, the convulsions, spasms, and death, even which may ensue from this cause.

The production of convulsions and spasm, from worms in the intestines, and indigestible food in the stomach, whose chief mode of action can be no other than an irritation excited mechanically in the intestinal and gastric mucous tissue, is a further illustration of the principle, and has already been noticed.* To the same purport may be cited the indomptable irritation of the locomotive nervous organs, causing tetanus, from splinters and other trifling injuries of this nature in the extremities, or mechanical irritants in the lower bowels. In these instances a local, and often in itself mere trivial irritation, is communicated to a remote organ, creates in it the same state of irritation, to the great disorder, and sometimes destruction of its functions. The only possible means of effecting this communication or translation of action from the primitive point of irritation to the organ secondarily involved, are the nerves and their power of transmitting and causing the repetition of the same action—excitement, stimulation, irritation—in different tissues and organs.

From the identity of nervous power, or activity, we may safely form the induction from these open facts and well established data, that phenomena perfectly analogous prevail in the ganglionic apparatus of the nervous system. An irritation excited in the tissues of an organ, embraced in the domain of the ganglionic apparatus, will be communicated to the centre with which it is in connexion, will be reproduced in that centre, will occasion in it the exaggeration or perversion of its forces and functions appertaining to that state, and will be thence necessarily continued, transmitted, or reflected into the other organs with which it is placed in communication, and receive stimulations from it, establishing in them the same state, and corresponding disorder of their functional actions.

The organs of the economy are maintained in action by the stimulation of agents endowed with active forces to which they respond. These agents are internal or organic, generated in the economy itself, as well as external. Nervous activity is one of

* Page 34.

the most prompt, energetic, and diffusive of the internal or organic stimulants. Its movements have a velocity inconceivable by the mind, and too rapid for our perceptions. This force is the property of the nervous structure, and varies in its intensity or quantity; increasing or diminishing, according to the varying state of that structure, modified by the activeness of its organic actions. Each portion of the nervous structure possesses its own activity, which is produced or evolved in itself—is attached to its own condition. Sensibility is not the same in every portion of the nervous tissue. It is more acute in one part than in another; it declines in one organ from prolonged exercise, while it continues in an active condition in other organs. It ceases to be manifested in any portion of the nervous structure when the organic actions are arrested by a deprivation of its circulating fluid, or by the ingress into it of black or oxygenated blood. Nervous activity or force being thus dependent on the state of the nervous structure, and its organic actions, whenever the tissues of an organ, rich in nervous structure, are stimulated into increased action, the movements of vitality are exalted in it, or irritation is established, and the nervous elements partake of this state; then the nervous activity of that organ is augmented or evolved, the organ is more sensitive, more irritable; nervous stimulation emanates from it with increased vigour, and is imparted to the nervous centre with which the organ is in communication; and this centre again reacts in a similar mode on other organs embraced in its connexions. Each organ in action is, in this manner, a point radiating stimulation to the other organs of the economy, and concurs directly as an excitant, independently of its functional actions, to the maintenance of the vital movements of the whole organism. A distribution and intercommunication of excitation amongst the organs of the economy is accomplished by this process, not unlike the distribution of heat amongst surrounding bodies, by the radiation of caloric, each organ emitting, radiating, and receiving nervous stimulation, according to the quantity of its nervous elements, and the activity of their actions.

In the natural state of the organism, the correlation and mutual play of the organs on each other, through the medium of the nervous system, and by the radiation of its ingenerated nervous activity, are not characterized by features so striking, as to be

readily seized on and established. They nevertheless do exist, and are what is to be understood properly of the *synergia* of writers. In the pathological state, the evidences of this mode of connexion and influence are too apparent to be misunderstood. The pathological phenomena are, however, no more than an exaggeration of the physiological phenomena. When an organ, in a state of active irritation, or acute inflammation, acts on another and distant organ, affects it in the same manner, communicates its own condition, it is not that a connexion is established, which did not before prevail, or a mode of action and influence is brought into play which previously had no existence. The connexion was already there; the action and influence already had being; and, as from this natural or physiological connexion and influence, the organs harmonize and correspond to each other in health, so from the same cause, are they participants of the same condition in disease. It is from this natural, fixed connexion and influence, that an organ, pathologically excited, generating in itself by the nervous elements of its structure, an excess of nervous activity, becomes a morbid or pathological excitant to the other organs embraced in the range of its nervous circle; or with which it is in most intimate nervous connexion.

When the organic actions of an organ, from the abstraction of its normal stimulants, excessive congestion of its tissues, or from any other cause, are enfeebled, or reduced in activeness or power, the production of its vital force, its irritability, its sensibility, its nervous activity, all depending on the organic actions for their production, decline; its vital phenomena, are diminished; it ceases to radiate its accustomed nervous stimulation or vibrations to the nervous centres, and thence into the organism; and a sedation, diminution of the vital movements or the organic actions, an asthenia, follow as a necessary consequence, in the whole circle of organs in its connexion, and frequently in the whole organism. This may even reach an extent terminating in death.

Instances of this last category of phenomena are presented in the rapid dissolution so frequently resulting from intense gastric and enteritic irritation and inflammation. The establishment of the disease is productive of extreme disorder in the heart, in the capillary circulation, in the respiratory organs, in the secretory apparatus, in the brain, in the nervous centres of sensibility and

locomotility, from the excessive morbid stimulation of the irritated and inflamed tissues, reflected through the ganglionic apparatus and its central organs, into the different organs of the economy. The intensity and number of the secondary phenomena, correspond with the intensity and aggravation of the primary gastric, and enteritic symptoms. These suddenly terminate, the tissues disorganized with the vehemence of their actions, or oppressed with congestion, are struck with death; their vital movements and activity stagnate, and they cease to be a centre radiating morbid stimulation or excitement, perturbative of the organic actions of the tissues and organs. Immediately the functions of the organs, which, as yet, were but sympathetically disordered, in running down the scale of excitement, by the withdrawal of the disturbing stimulation, resume and preserve for a short period, their healthy or natural state. The patient rises from his bed, he feels the invigoration of returning health, he pronounces himself restored, he walks about, he converses with his relatives and friends in his usual spirits and state of mind, he takes to his books, writes letters, looks after his affairs. His recovery is considered certain, and regarded as almost miraculous. An inexperienced medical attendant may be deceived by the fallacious aspect of the case, and be led to the formation of a false prognostic. The delusion soon vanishes—a sentiment of inward failing is perceived, it rapidly becomes a feeling of extreme exhaustion, a fainting debility seizes on every organ, the surface is algid and pallid, a cold and clammy sweat breaks from every pore, the respiration is hurried and feeble, the mind wanders, the senses are obscured, the efforts of the muscles are tremulous and without force—life is escaping from every avenue, and where, but a few moments before, was the animation and brightness of hope, is now spread the darkness of despair.

The speedy and entire change induced in the organism by the death of the stomach, does not proceed from its dependancy on the function of that organ. Life may be protracted a long period during its suspension, or with its complete deprivation. But with the cessation of its organic actions, or vital movements, terminates the production of its sum of vital activity and stimulation engendered by the organic actions. A positive loss, an immediate and direct abstraction of vital stimulation is sustained, the ener-

vating and sedative influence of which, from the ganglionic centre that is first assailed, is soon extended from organ to organ, augmenting with a progressive ratio, until the whole economy sinks under its fatal depression.

The *sedation* or *asthenia* of an organ, that is, the direct or indirect enervation of the organic actions, is imparted as well as stimulation or excitement, to other and remote organs, through the connexion established by the nervous apparatus, and is thus an operation of sympathy, together with its opposite condition—irritation. To this circumstance it is that a sedative treatment directed to organs elevated in the rank of the sympathies, can be brought to bear its influence on the whole organism.

The connexion and influences of the organs on each other, constituting sympathy, exist in health as in disease, though not as perceptible by clearly-marked phenomena. From this cause the fact has been overlooked, and the term *sympathy* is generally used as expressive of the phenomena, provoked by a pathological state. It does not, however, differ from the established relations of the organs—and sympathy is nothing more than the natural relations, connexions, and influences of the organs, acting or sustaining and exciting each other, more decidedly pronounced and positively characterized than in health.

IV. In the foregoing investigation it has been attempted to reach definitive views, 1st, of the proper phenomena of sympathy; 2d, of the material organ or apparatus of sympathy; and 3d, of the nature of sympathy, or the kind of action in which it consists. It now remains to inquire into the utility of sympathy—to ascertain the *cui bono*, the *wherefore*, for which it is instituted, and the advantages it offers to the economy. Viewed at first superficially, and seen only as propagating disease from organ to organ, it might be regarded as an injurious rather than a salutary provision, from which it would have been a beneficial arrangement for the organism to have been exempted. But thoroughly understood and justly appreciated, *sympathy* will be recognized as an operation of preservative tendency, in the highest degree salutary, and forming the base of all the recuperatory actions of the economy—the natural methods of cure and restoration. It is the master-key of many leading pathological phenomena, the true character of which, it is conceived, cannot be correctly com-

prehended without the aid of a sound and just doctrine of sympathy.

The organs, whose functions are the means of existence, being composed of tissues endowed with a high degree of irritability—of vital activity—are, consequently, susceptible of numerous impressions, are acted on by an immense variety of agents, with which they are brought into relation, possessing active forces and perturbating properties. The organic actions, or vital movements of the tissues, are thus subject to be directly disturbed in their natural order, in a violent manner, and by means it is not possible to guard against, or controul. The functions of the organs themselves, dependent on the organic actions of the tissues, when pushed to excess, as they so frequently are by man in a civilized state, are additional causes of constant disorder in the play of the organic actions.

But the organic actions, or vital movements, formative of the tissues, and consisting in the play of the organic affinities, acting on the organic elements, are called into existence, and are maintained by the unceasing impressions or incitements of exterior agents, named stimuli or excitants. They are an excitation. The most common deviation or modification of these actions, is their vitious augmentation, their exasperation, by the operation of too powerful agents, tending, by the profound modification impressed on the combinations of the organic elements, to the disorganization or alteration of the tissues. To this state or aggregation of phenomena, is given the name of *irritation*, and they are always to be regarded as implied by this term.

But the establishment of irritation, in a manner inexplicable from our ignorance of the motive powers of the sanguine fluid in the capillary and intertextular angeial tissue, gives a direction of the fluids contained in it, concentering them from all the tissues and organs to the tissue or organ in which that condition has been developed.

When this movement is continued, and is not arrested, the sanguine fluid accumulates in the irritated tissue, acquires an excess beyond the proportion natural to its structure or organization; its properties are profoundly affected, and its functions are equally implicated—they deteriorate, are suspended, or are destroyed. Congestion is then formed, which is excessive accu-

mulation of the sanguine fluid element, creating *hemostasis*, or stagnation of the blood.

The opposite condition prevails in the organs remote from the seat of the irritative movements. They are robbed of the proportion of sanguine element necessary to their healthful constitution, an exhaustion, a debilitation, a sedation of their vital activity ensues—hemostasis from deficient power is induced, and the functions either languish in extreme feebleness, or are entirely annulled.

This condition often occurs, and frequently with a frightful and incontrollable rapidity, when highly vital organs, rich in the capillary angeial tissue, and abounding with the sanguine element, are assailed with violently perturbating impressions. This is the constant tendency, the disposition of the irritative and inflammatory affections of the abdominal viscera, occasionally of those of the thorax, and sometimes of the brain. It exists in the onset of all febrile diseases; it is especially marked in these affections when prevailing in southern and tropical climates; it is the peculiar character of malignant intermittents, of spasmodic cholera, of calculous nephritis, and is a predominant element in ataxic fevers.

The continued progression of this movement, the prolongation of the series of phenomena attending on and awakened by acute internal irritations, if not arrested, would, in all instances, prove imminently threatening of fatal congestions, and equally fatal exhaustion. But this result is prevented by the establishment of *reaction*, as it is termed. Let us then ascertain what are the phenomena of reaction, and the manner in which it is produced, that the term may possess a positive value, and be employed with a definite meaning.

In reaction the movement of concentration and centralization characteristics of the preceding, or the forming period of irritation, is arrested, and is replaced by a movement of diffusion and expansion—a centrifugal opposes, and subdues a centripetal action. The series of phenomena is reversed; a new series is substituted. The tissues and organs which manifested the most profound asthenic exhaustion, with the loss of their functional operations, exhibit reviving power and activity, they momentarily reassume their natural state, rapidly transcend it, acquire force

and energy, and finally rush into the perturbation, disorder, and derangement of morbid excitement. The organs which were oppressed with the congested load of fluids that had been precipitated on them by the first movement of concentration, are relieved; the excess of the sanguine element that had overwhelmed them is reabstracted and diffused—they are restored to calm, a more regular exercise of their functional duties ensues, and the whole organism reverts gradually, after repeated fluctuating movements, to a natural state. Reaction is thus a recuperative process, equalizing the forces of the organs, and reestablishing the balance of the organic actions, and the equilibrium of the capillary circulation when overthrown.

The phenomena of reaction are accomplished by an excitement developed in the organs, whose forces, actions, and circulation, had been enfeebled in the first instance under the influence and concentrating movements of pathological irritation. This is the first of the perceptible phenomena in the series. Excitement—that is, the augmentation of vital activity and movements, cannot occur or be sustained without an increase of the sanguine fluids, one of the elements of the tissues, and an indispensable party to the act of excitement. Excitement being induced, a necessity is created for the presence of the sanguine fluid in the excited tissue—a species of affinity is developed between the solid element and the fluid element, which retains the latter, resists its abstraction, extends its influence abroad, as the excitement is augmented, and attracts or demands the fluid element of all the other organs. The seat of every irritation is always, therefore, a centre of adfluxion for the fluid, or moveable element of the organism, whose circle possesses a radius proportioned to the intensity of the irritation, the rank or influence of the tissue in the organism, and its role in the sympathies. But excitement is always the result of a stimulant or exciting agent, whose power is brought to act on a structure endowed with vital activity. In natural or physiological reaction, the stimulant force not being derived from any external source, must proceed from the organism itself, and as no organ can obtain its exciting force within itself, the excitement induced is the propagation, the extension of the stimulation, by sympathy, in the mode precedingly indicated, resulting from the primitive irrita-

tion already established. Reaction is therefore the sympathetic propagation and secondary repetition of an original irritation developed in a tissue or organ remote from that primitively affected, whence results the production of forces, and establishment of movements, having a therapeutic operation, and recuperative tendency, directly opposing, resisting, and most commonly overcoming the forces and movements of a pathological character operative of a disorganizing process, and possessing a fatal tendency.

Reaction is thus seen to be an effect accomplished always by *sympathy*, and it is for the purpose of instituting this great, protective, and recuperative process of the economy which interposes its preserving agency in so many threatening dangers, that the sympathetic connexion of the organs through the ganglionic apparatus has been provided.

When reaction is diffusive, when the sympathetic irritations are spread over an extended surface, when they have seized on a number of organs, and the vital activity and movements of the tissues are carried beyond the natural type or normal grade, the circulation having its velocity considerably increased, and the animal temperature being elevated above its standard, the phenomena then exist, to which is applied the term *fever*. We thus obtain the positive import of this term, and the character of the phenomena it indicates, the more precise nature of which was pointed out under the section treating of the animal temperature. *Fever*, and *reaction in excess*, are precisely the same; they are both effects; they are properly symptoms rather than disease; they are sanitive and salutary in design; they are the evidences of power and force which admit of remedial and curative operations; and they are in themselves the recuperative processes of the economy in action instituted for its preservation.

In arriving at a knowledge of *fever* by the way of analysis, the proper phenomena to which the term alone is applicable, and to which it should be restricted, are easily appreciable, and can receive a positive determination. This problem has continued unsolved to the present period, has been the most disquieting question of the science, and has heretofore defied the attempts, even of the most gifted, to give it permanent form, or settle it on an established base. This difficulty has proceeded from a con-

crete having been mistaken for a simple phenomenon, from fusing into a common mass effects and causes, and then studying them in this collective state, when, according to the accidental mode in which they happened to be regarded, they presented a different aspect to each observer.

The adoption of the analytic method corrects this error, separates each phenomenon of the aggregate, and assigns to it the exact location it occupies in the series. Its proper nature, and its just value, are then ascertained, and the influence it should possess in the arrangement of a system of treatment is clearly discerned, and taken at its correct estimate.

In all the disquisitions on fever, two things entirely dissimilar have been constantly confounded—the primordial affection, and its consequences or effects—the root and the branches—the disease and its symptoms. The last striking the senses are immediately perceived, make the strongest impression, and often occupy exclusively attention. Symptoms are but the outward signs of disease, are its language, and to be perfectly understood, and acted on intelligibly, must be converted into their positive meaning. This can alone be accomplished by the means of analytical anatomy and physiology, natural and pathological—that is, a thorough knowledge of the elements, the structures or tissues, the organs and apparatus of the animal organism, with the peculiar properties, characters, phenomena, and functions of each. Until the cultivation of anatomical and physiological science took this direction, and this knowledge was developed, it was not possible always to comprehend the meaning of symptoms, or to discriminate symptoms from disease. This was peculiarly the case with fever. It was recognised without difficulty as a symptom of the inflammation of certain organs, though the mode of its production could not be understood. But it also existed when, from imperfectness of knowledge, the absolute ignorance of general or analytic anatomy and physiology, it was impossible to recognise or ascertain either an inflammation or any other material affection of tissues and particular organs. It is not then surprising that fever should have been regarded as of a most mysterious and almost incomprehensible nature, whose obscurity embarrassed the profoundest intellects to penetrate, and defied the ordinary modes of investigation. There was nothing positive

to rest upon. Beyond the mere fact of the obvious general disorder of the functions, the remainder was a void, which the imagination attempted to fill up. In the absence of the proper materials, no substantial doctrine could be formed. Truth could be elicited only by a happy inspiration, which, in science, never does more than to present mere glimpses, useless for any practical purposes. For the greater part, the professed treatises on fever, have been works of imagination, composed in the style of romance—fancy sketches—or are profound metaphysical abstractions, filled with subtleties, and hypothetical reasonings. So accustomed are the medical public to see fever treated in this mode, and to regard it in the light of a mysterious operation of the economy, that few will be disposed to admit, from their mere simplicity and singleness, the principles for a doctrine of fever, at which we have arrived, from a decomposition of the phenomena included in this term, by the way of analysis.

From these principles the term *fever* acquires a definite meaning, and is significant of positive phenomena to which it is restricted. It ceases to be a concrete, in which it is attempted to combine together and form an abstraction of all the phenomena resulting from the complicated disorders occasioned by the affections of the various organs in the diseases called *fevers.* On the contrary, *fever* is but a part of the phenomena attending on those diseases, most generally present, but, as every practitioner of experience must know, often does not occur. Fever cannot exist without reaction—it is reaction carried to excess and obtaining a certain permanency, or the radiation of a primitive irritation, exciting at the same time the heart, and the organic actions of various tissues and organs, increasing the velocity of the circulation, and augmenting the animal temperature. Fever is, consequently, an effect or symptom, similar to reaction, and, like reaction, is salutary in intention, and relevant in operation. It is a common phenomenon, which may attend on the irritations of any tissue or organ capable of awakening the phenomena of sympathy.

In treating of the diseases designated as *fevers*, this common symptom, which, from being the phenomenon the most obvious and easily seized on, has usurped the chief consideration, and imparted its name to the whole class, should be carefully sepa-

rated and distinguished from its cause, the primitive affection or irritation of an internal organ or tissue. This last, the radix of all the mischief, veiled from the sight, is too generally overlooked, or when recognised, its nature and influence are too frequently misunderstood. In the practical management of these diseases, this discrimination and just appreciation of the different phenomena they manifest, cannot be too highly estimated, and, it is to be apprehended, a neglect of them has too often led to unhappy issues. To attempt the sudden and violent suppression and extinction of the symptom *fever*, or reaction running to excess, by extreme exhausting evacuations, is an unsafe practice. It is opposing and defeating a recuperative operation, the most efficient that can be accomplished, and instituted for the express purpose of protecting the organism against the consequences of this very condition: fever is a provision of nature for the safety of the economy. Similar to the recuperative processes, secretion, effusions, hæmorrhage, fever may err from its excess, or the reactive irritation may assume an unsafe direction. The object of the treatment of this phenomenon or symptom should, therefore, be merely to limit its energy, to restrain it within due bounds, and to govern its course, but not to extinguish it utterly. Should the blow aimed at this mere secondary effect, or the symptom *fever* fail to eradicate the primitive irritation, which seldom can be accomplished except in light cases attended with little danger, or, in its commencement in highly vascular organs, as the lungs and brain, the organism is prostrated, the unaffected tissues and organs are enfeebled, and thereby incapacitated, from interposing their protective agency, by the destruction of the power necessary to the action of sympathy, or the radiation of irritative actions, and, consequently, the affected tissues and organs abandoned to themselves, their vital activity and energy oppressed, they offer but little ability for resistance, possess but a faint capacity of restoration, and most commonly succumb in the unequal contest. The patient, when this condition has been induced by this intemperate treatment, is placed in the worst possible situation. He is in the same state with one in whom reaction has never taken place; with this additional disadvantage, that the exhaustion and debilitation induced in the economy disqualifies the organs from executing the process of reaction.

The impression or irritation developed by morbific agents is often so violent as to prostrate the vital forces and activity of the tissues, and to depress their organic actions to the lowest ebb, by the extent and intensity of the congestion suddenly induced. The sympathetic relations or connexions of the organs are then broken up, are overwhelmed or destroyed. Sympathy is paralyzed or extinct: radiation of the irritative impression and action cannot occur, or is effected with extreme difficulty and tardiness. The organism is threatened with rapid destruction from two opposite causes—the death of the tissues, the field of the morbific impression, caused by the extreme depression of their organic actions, crushed beneath the load of congestion; and the cessation of the organic actions of the unirritated tissues, enfeebled, debilitated, asthenic, from the exhaustion of their sanguine element.

This violent suppression of the sympathetic actions, this disruption of the relations and communication between the organs, destroying the unity of the organism, is a result either of the exceeding energy of the morbific agent and violence of its impression, or of a constitutional or accidental derangement in the harmony of the relations and connexions of the organs—some one tissue or organ having acquired an unnatural development or activity, conferring on it an ascendancy over all the others. The two causes may be co-operative at the same time, when the destruction of the organism is wrought with a fearful rapidity.

The last cause existing in individuals labouring under chronic inflammations, in those of intemperate habits, in those who lead irregular lives, who are subjected to the privations, the exposures, the hardships of poverty and wretchedness, who dwell in confined, damp, and filthy habitations and localities, exposed constantly to insalubrious exhalations and unwholesome impressions—it is those individuals who most frequently present this condition of sympathy, who manifest this array of phenomena, and who succumb beneath the blow with scarce an effort to resist it, the assured, the selected victims of every epidemic disease.

This condition of sympathy, its paralyzed state, its incapacity to radiate and diffuse a local irritation, and excite reaction, is the important, the essential character of *malignant intermittents,* especially of the algid form, known in the southern states as *cold*

plague; it is the peculiar feature of the *epidemic* or *spasmodic cholera,* now devastating the lower orders of society in Europe, and a visitation of which may be looked for in this country in its progress round the globe.

From the foregoing principles, the treatment of the diseases named *fevers,* before they become complicated by vitiation of the nutritive sanguine fluid from the suspension or perversion of the functions, which introduces new considerations, may be embraced in the following propositions:—

1st. To mitigate or abate the energy of reaction, or the febrile symptoms when threatening injurious consequences from excess.

2d. To reduce the primitive and perturbative irritation by the means producing the most prompt and efficient sedation, directed, when practicable, to the tissue and organ the seat of this irritation.

3d. To protect, by topical and local treatment, vital organs from the secondary or radiated irritation—or to reduce and keep it within safe limits when it has occurred.

4th. To impart a direction to the sympathetic or radiated irritative actions, towards organs whose functions are not immediately vital, by developing in them artificial excitement and irritation, and thus diverting the morbid irritation into safe channels.

5th. To resort to the employment of evacuant irritants, excitants, stimulants, and tonics, when the intensity of the primitive irritation has declined, the sympathetic reaction is enervated, or has ceased, and the original irritation is converted into, or is about to become a local disease. By exciting and invigorating the actions and functions of the healthy tissues and organs, they are made to cure the original disease by the establishment of an artificial crisis, imitating a natural process of relief, or by diffusing and dispersing the enfeebled irritation throughout the economy, by a species of general metastasis or revulsion. This class of remedies, when their mode of operation is understood, and they are judiciously employed, is often the most efficient means for the cure of irritations and inflammations. In employing them, it is proper to respect the tissue or organ the seat of the irritation, and to resort to those that possess no relationship

with it; that do not act on, or but slightly affect it; that may be introduced into the economy by another route, leaving it untouched; or that pass over, leaving it undisturbed to expend their force on some other tissue or organ.

6th. To produce a diffused permanent tonic excitement and general invigoration of the organic actions, throughout the organism, by the employment of tonic remedies, especially cinchona, or its active principles; or a diffused persistent pathological irritation—as by arsenic—when a local irritation, reduced, but not extinguished by the sympathetic radiation, or febrile reaction, is re-exacerbated, or re-acquires its original intensity, at different intervals, productive of paroxysms, creating a fluctuating movement or raptus of the capillary sanguine fluid and forces of the tissues, or assumes an intermittent type.

The diffused excitement of the organic actions by these agents causes in each tissue a demand for its own sum of sanguine fluid, always proportioned to the activity and energy of its vital movements. A therapeutic force is thus called into requisition in all the tissues, resisting the local pathological force developed in the irritated organ, and though it possesses in each a less intensity than that which is morbid, yet the whole sum of resistance presented by so many points throughout the organism, in the aggregate, is superior. The movement of concentration or centralization cannot then occur, the first phenomenon in the series is prevented, and the paroxysm is defeated. Should the local pathological irritation be neglected, its symptoms be merely suppressed, while it is suffered to persist, on the subsidence of the artificial or therapeutic excitement, the irritation will be re-invigorated; the irritated tissue or organ will renew its morbid activity, will acquire its morbid ascendancy, subjecting all the others to its influence; and relapses continue to recur.

7th. To awaken the vital activity, to produce a movement of expansion or radiation, the diffusion of irritation, or the excitement of febrile reaction, by the conjoint administration of diffusible stimuli and excitants internally, by capillary depletion, and, in some cases, general depletion, with the employment externally of all the exciting means that can be brought to act on the skin, as heat, frictions, rubefacients, vesicatories, cauteries, &c. when an internal irritation, from its intensity, or other

causes, remains concentrated on a tissue and organ, paralyzes or suppresses the sympathies, prostrates the connexions of the organs, and, by causing a centripetal movement of the capillary circulation and concentration of the sanguine fluid, is productive of a disorganizing congestion and fatal hemastasis, or stagnation of the blood.

The foregoing propositions for the treatment of the class of diseases known as fevers, drawn from an analysis of their phenomena, are calculated to meet the indications presented by the phenomena of a dynamic character, independent of those arising from alterations and vitiations of the crasis or constitution of the blood, and of the secreted products. These are complications, most commonly effects, resulting from the action of the preceding phenomena, and which require entirely different considerations.

V. To render complete the history of sympathy, it now remains to indicate the fixed general phenomena or general laws observed to prevail in the sympathies deduced from clinical facts and experience.

1st. Sympathy is not a mere pathological phenomenon; it is a physiological fact, exaggerated or developed in disease.

2d. Individuals differ in the activity and number of their sympathies from their general or constitutional organization. Those in whom the nervous and vascular tissues are most developed and abounding, manifest the most active sympathies. Children and females, from this cause, have sympathies more acute than the aged and male sex. Individuals of the lymphatic temperament, will perish from inflammations which are scarcely suspected, being masked by the inertia of their sympathies.

3d. All the tissues and organs do not occupy the same line in the role of the sympathies. They manifest in this respect very great diversity.

a. The tissues and organs, the most highly organized, the most vascular and richly endowed with nervous structure, and the most intimately connected with the ganglia, the centres of the ganglionic apparatus, are those most elevated in the sympathies. These circumstances impart the predominance possessed by the gastric tissues and digestive organs in the sympathetic connexions of the organism, which make them as it were the representative of so many disorders, the source of such numerous

affections; and gives to the impressions of therapeutics agents exercised on them so extended and profound an influence in modifying the organic actions of most of the tissues and organs.

b. The irritability of a tissue or organ, whether natural or acquired, determines its rank in the sympathies. The organs the most irritable, are those most active in the sympathies. A feeble impression on an irritable tissue will excite very general disturbance through the activity of its sympathy; very profound impressions on organs of a low degree of irritability, are scarcely felt beyond their local action.

4th. Sympathy being the connexion influencing and modifying the state of the organic actions, or vital nutritive movements of the various tissues of the organism, accomplished always by nervous stimulation, whenever irritation is excited in any one tissue and has acquired a certain intensity, it is most generally extended to and repeated in other tissues and organs. If the irritation possess a low intensity, or the subject is constitutionally from his organization inirritable, or it occurs in an organ of feeble irritability, sympathetic radiation does not occur, and sympathetic disorders do not announce the existence or the extent of the disease.

5th. The sympathetic or radiated irritation corresponds, and is of the same character with the original irritation. Acute irritation rarely fails to awaken the sympathies, to be radiated into remote tissues, and to excite secondary disturbances. Chronic irritation frequently does not cause any sympathetic disorder.

This law governs the course, most generally, of irritative diseases. They possess a less duration in proportion to their intensity, the consequent sympathetic disorders induced, and the importance to the economy of the functions of the organs secondarily involved. Intense irritations speedily terminate either by metastasis, critical evacuations, or disorganization and death. Chronic or feeble irritations are protracted in proportion to the quiescence of the sympathies. When the mucous tissue of the stomach, in chronic diseases, becomes sympathetically irritated, its supremacy in the offices of the sympathies, from its immediate connexions with the great centre of the ganglionic apparatus, immediately gives an extension to the irritation or enhances its effects. The functions of the capillary tissue are disturbed, the

heart experiences its influence, and the phenomena of *hectic* fever are developed. This result may occur independent of the co-operation of the gastric mucous tissue, but it is an uncommon occurrence. I cannot assert with confidence I have ever met with it. In the treatment of chronic inflammations, this fact is of great moment, for it enforces the precept of respecting the stomach and its functions, and of avoiding to torture and disturb it by the lavish employment of irritating medicines.

6th. When remedial or medicinal means of an irritating character are employed, and whose operation depends on their absorption and introduction into the organism, they should not be applied, if possibly to be avoided, to an irritated surface. By augmenting the irritation, they extend it more certainly through sympathy, into other tissues and organs; they produce effects counteracting the intention for which they are prescribed; and often develope unexpected symptoms and produce complications of affections not anticipated.

Opium administered by the stomach in gastric irritations exasperates most commonly the disease, and prevents, by the sympathetic radiation of the morbid irritation on the brain, its anodyne and calming influence on that organ. Quinia and other tonics, exhibited before the gastric irritation so frequent in autumnal intermittents has been subdued, fail to accomplish the cure so certainly effected when this state has been dissipated. They may mask the disease and strangle the paroxysm, but it is done by converting an intermittent or fluctuating irritation, tending to its own cure, into a fixed irritation and sub-inflammation, affecting not only the stomach but extended to the brain, or lungs, or liver, or spleen or other viscera. Antimonials and other emetics directed in nauseating doses as sudorifics, will be productive of convulsions, cerebral irritations, and apoplectic symptoms. Digitalis, by increasing gastric irritation, and thus stimulating the action of the heart through sympathy, quickens its contractions and the frequency of the pulse, when it is introduced into the stomach suffering under irritation. The sedative or depressing influence of the medicine over the central organ of the circulation is in this manner defeated. In all such cases, it is preferable to introduce these medicines by the endermic application, or by injection into the rectum.

7th. When a tissue or organ, which in its natural state appears scarcely to be included in the connexion of the sympathies, displaying little or no influence over the actions of other tissues and organs, nor affected by them in return, has irritation excited in it, with its augmented vitality, its increased irritability, arises a close sympathetic relation with the organism, by which it rivals in many instances, in this respect, the most important of the tissues and organs.

This law is fruitful in its application to pathological and therapeutic phenomena, and enables us to understand many circumstances belonging to these departments regarded as anomalous. The accidental sympathies, as they are denominated, are also explained by it.

Many exemplifications might be adduced to illustrate the bearing of this proposition. The osseous, cartaliginous, and fibrous tissues, in their natural state, it is well known, from the low grade of their vitality, if they possess any share in the sympathies, occupy the last positions in the scale. Let, however, irritation be excited, let inflammation arise in them, their vitality is more active and elevated, the fluid and vital element predominates over the solid and inert element, their irritability increases, and sensibility, of which they were previously destitute, is acquired. They are now active in the sympathies—they now radiate irritation through sympathy into other tissues and organs, disturbing their mode of being: the stomach, the brain, the heart are disordered in their functions, nutrition and secretion are affected—fever is developed. At the same time these tissues participate in all the morbid derangements of other tissues, and immediately respond to stimulation excited in distant organs. Patients suffering under acute inflammations of those tissues find a prompt aggravation of their sufferings, and worse condition of the disease, to follow an indulgence in exciting food or drinks. An attention to regimen is indispensable to their comfort as well as recovery. Even acute urethritis, though occupying so small an extent of surface, and apparently so insignificant, has all its symptoms rendered more severe from a single glass of wine or of alcoholic drinks, or the use of exciting condiments.

The conservative action of issues proceeds from the operation of this general law. By making a fixed point of irritation in the

skin, in chronic inflammations, a diverticulum of excitement is created, by which irritation is attracted from internal surfaces whose functions are of importance in the economy, a diversion is imparted to sympathetic radiation protecting organs of vital influence, and directing it on a surface where it is harmlessly expended.

8th. Tissues and organs left in a state of chronic inflammation, or whose vital activity is heightened by the constant exercise of their functions, acquire a pre-eminence in the sympathetic connexions, and are the first to receive the radiation of irritation, and to suffer disorder of their functions from sympathy.

Chronic inflammation existing in the stomach too feeble to awaken sympathetic disturbance in other organs, is aggravated by irritation in the lungs—as in phthisis, chronic pneumony, &c. or in other organs suffering under inflammatory irritation; it then acquires the power to call the sympathies into action, extends the irritation to the heart, to the capillary tissues and glandular organs, and the phenomena of fever are produced. This is a common mode of the production of *hectic fever*, and if the mucous membrane of the stomach and intestines be preserved exempt from irritation in those affections by attention to appropriate food and an abstinence from irritating remedies, patients will be conducted through the disease without a paroxysm of hectic fever being excited. I speak this from ample experience.

Surgeons should be aware of this fact, and before the performance of important operations they should examine well into the condition of the digestive apparatus, especially the stomach. The violent irritation of the operation is almost certain to be extended to the stomach, the organ of all others the most exalted in the sympathies, from its close connexion with the central ganglia and plexus of the ganglionic apparatus. Sympathetic fever is in this manner excited, and if the stomach be in a state of irritation at the time of the operation, it acquires an intensity which may become fatal.

Individuals who are exposed to constant powerful cerebral excitement from exertion of the intellectual or moral faculties, whenever they are attacked with gastric irritation sufficient to excite a febrile movement, are certain to suffer from some cerebral affection. Professional persons, especially lawyers, states-

men, and the members of our legislative bodies, who participate actively in political discussions, all of whom are subject to high excitement of the passions and intellect, are the most liable to cerebral disorders, and manifest most frequently cerebral complications in their diseases. The brain in them is an organ constantly to be watched, and to be guarded in their affections from the effects of sympathetic radiation.

In the periods of professional excitement they should be cautious of irritating the stomach by full meals or by stimulant food and drinks. An attack of cerebral inflammation or apoplexy may be an unexpected consequence, and to which so many distinguished men of those professions have fallen victims.

9th. Irritations attended with pain excite the sympathies with more rapidity and certainty than irritations of equal intensity unaccompanied with pain; but simple nervous pain, disordered sensation—neuralgia—has no influence in exciting the sympathies. Individuals will suffer excruciating neuralgic pains, both external and visceral—gastralgia, enteralgia, hepatalgia, &c. and for years, without experiencing the slightest sympathetic disorders or febrile movements. The neuralgic affections, especially the visceral neuralgias, are often confounded with inflammatory irritations, leading to erroneous views and misconceptions of doctrines, and suggesting a treatment which invariably ends in defeat, often aggravates the evil, and is sometimes exceedingly injurious in its results.

This proposition indicates the impropriety, during the height of acute inflammatory disorders, of employing remedies excitative at the same time of pain and irritation—as blisters, cauteries, &c.

10th. The sympathetic irritation when it has not attained a degree of intensity equal to the original irritation, ceases on the subsidence of this last; but when it has acquired a force rivalling that which has given it origin, it often becomes permanent, and will continue after the irritation of the tissue or organ primitively affected has disappeared, or been subdued by remedial operations.

The fact announced in this proposition, while it sustains the necessity of attacking by the most direct and appropriate means, the primordial irritation of the tissues, inculcates the propriety of not neglecting those that are of sympathetic or secondary origin.

11th. The sympathies of the different tissues and organs are reciprocal. Those that excite most frequently sympathetic irritation, which must readily radiate irritation when excited in them, are the tissues and organs in which irritation is the most easily and most frequently excited by sympathy, which assume with the greatest facility the irritation radiated from other sources. The stomach and the brain are the organs in this condition, and excite and receive the greatest number of sympathetic irritations.

12th. Sympathetic irritation will be excited in the organs of the nervous apparatus of relation, disordering their functions and productive of serious diseases in them, by visceral irritation, especially when seated in the digestive or genital organs, which has not excited a consciousness of its existence.

In the apparatus of the voluntary motions, convulsions, chorea, epilepsy; in the apparatus of sensation, neuralgic pains; in the apparatus of the perceptive faculties, hallucinations, false ideas; in the apparatus of the intellectual and moral faculties, errors of combination, false judgments, disorders of the propensities and passions—mental alienation in its various modifications—very frequently are sympathetically provoked by irritation of a low grade or chronic character, seated in the digestive or genital organs, which has escaped observation, from the little suffering and disorder of function it has induced in its primitive location.

The preceding embrace the principal, if not the whole of the laws or the general facts of sympathy.

The study of the connexions of the organs, functional and sympathetic, is the complement of all physiological researches, and the fulfilment of pathological investigations. The more profoundly they are examined and the more clearly they are understood, with the greater facility will the production of morbid phenomena be comprehended, the mysteries that involve the pathological state be penetrated, and the perplexities proceeding from the complications and diversities of disease be unravelled. Let them never be forgotten by the practitioner when he stands by the bed-side of the sick. This knowledge is the rock on which he must build would he erect a system of treatment at once rational, safe, and efficient.

INDEX.

T.

THE END.

ERRATA.

Page 36	line 26,	dele off.
53	34,	for tænea, read tinea.
72	27,	" they, read the secretory organs.
76	38,	" its, read their.
78	11,	read Beclard for Chaussier.
86	33,	for effected, read affected.
113	32,	" organizations, read organic actions.
113	35,	" organizations, read organic actions.
121	7,	" on, read or.
124	29,	" assimilations—nutritions, read assimilation—nutrition.
142	33,	" idiopathetically, read idiopathically.
149	18,	dele injurious.
159	10,	dele are.
174	29,	add of, before "a want."
174	33,	for in, read of.
177	7,	dele to.
180	30,	for their, read these.
182	12,	insert, and agreeable, after "injurious."
182	13,	dele to.
190	37,	for to the, read in.
198	14,	" whence is, read where are.
205	8,	" but, read all.
205	12,	dele of.
246	16,	for vicious, read viscous.
274	11,	insert symptoms, before disappear.
317	7,	for the, read their.
422	10,	" union, read unison.
599	15,	" oxygenated, read deoxygenated.

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